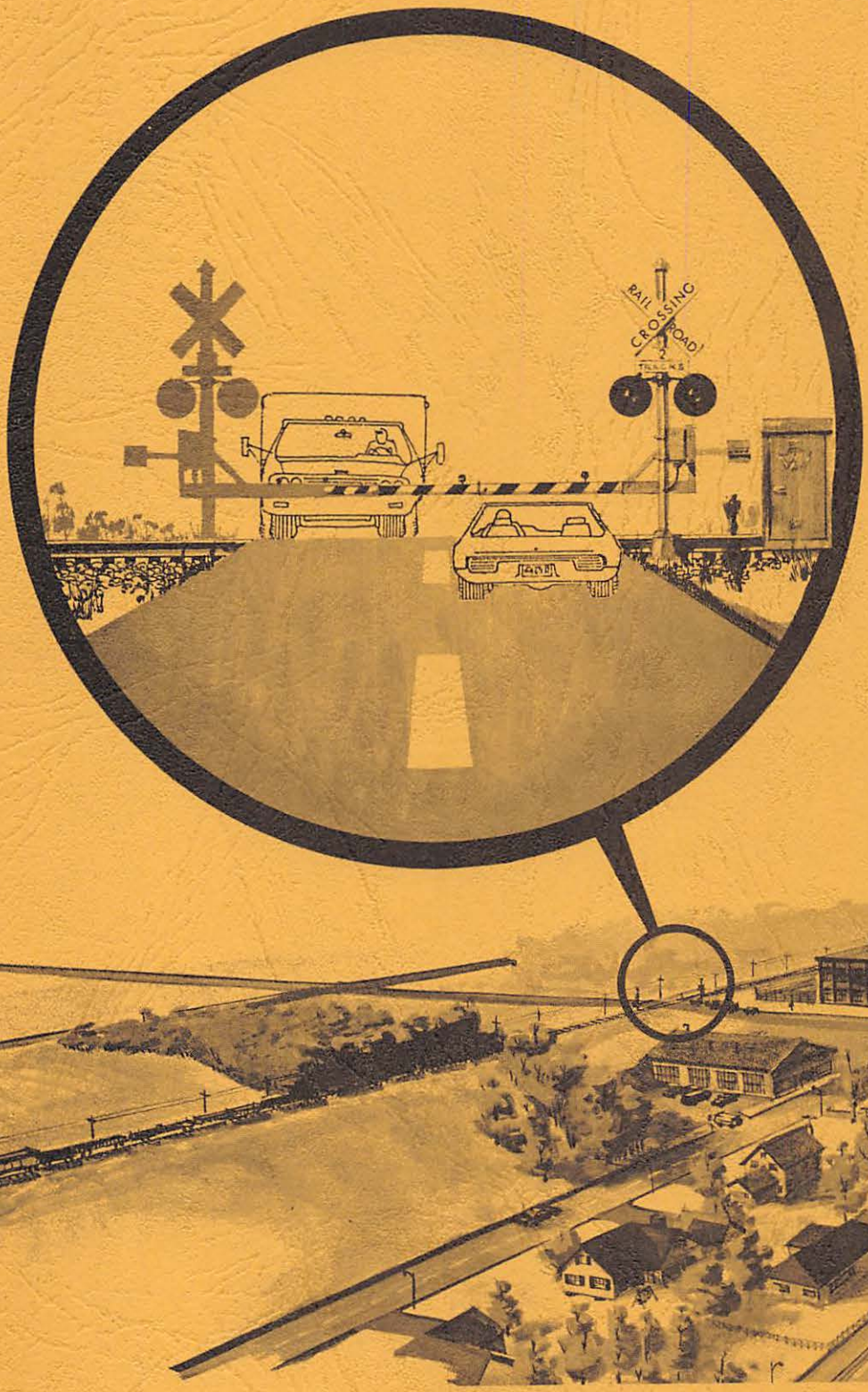
WABCO

WESTINGHOUSE AIR BRAKE COMPANY
UNION SWITCH & SIGNAL DIVISION
Swissvale Post Office, Pittsburgh, Pa. 15218
An American-Standard Company

HIGHWAY CROSSING

STUDY



1973

Additions:

Section II, page ii (Exec. Summary)

Section III, page ii (Exec. Summary)

Section II, page II-1

Section III, page III-3, para. 1

Page III - 4 (new page)

Section III, page III - 5/6 para. b(1)

Exhibit No. 3A (new page)

Geo Potts

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EXECUTIVE SUMMARY

I. INTRODUCTION

A study team surveyed the Highway Crossing market to determine the potential business, define problems and recommend an action plan to enhance the Division's market position. The survey included critical examination of both internal and external influences as well as customer attitudes and requirements. The report also includes an Action Plan as well as projected implementation costs.

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II. STATEMENT OF THE PROBLEM

The Highway Crossing market potential has been steadily increasing during the past 10 years, from $6.3 million in 1963 to approximately $17.1 million anticipated this year. During this same 10 year period our share of this market has dwindled from 27% ($1.7 million) in 1963 to approximately 9%, or $1.6 million anticipated this year. (Please note not included 2)

> The WABCO share figures do not include relays ordered on SP&E orders. Based on the projection of approximately 1600 highway crossings being installed during 1973 and using an average of 10-15 relays per crossing, another $1.1 to $1.6 million can be added to the WABCO share. This would bring our total share to $2.7 - $3.0 million, or approximately 16 - 18%.

potential by 100% to 200% over the next several years. In addition, recent emphasis on industrial safety as promoted by the Occupational Health and Safety Administration (O.H.S.A.) is accelerating market activity by Commercial Industry. ~~This~~

> This area has been conservatively projected at $2.7 million in 1974. $3.2 million in 1975 and $3.8 million in 1976.

Where did this data come from?2

IV. PROBLEM AREAS

A review of our recent experience in the Highway Crossing business area indicates that we have not been successful in meeting the needs of our customer either on a timely basis or, in some cases, on a competitive basis. In analyzing the underlying causes for these problems it became clear that, although several attempts have been made to cope with the unique requirements of this business area, we simply have not been successful. The reasons are many and varied but suffice it to say that divisional operating procedures and practices are geared to business areas which have different requirements than the Highway Crossing area. More specifically, experience indicates that we cannot routinely expect to achieve the required timely responses under present conditions.

The Highway Crossing market is a 30 day delivery market, and if we want to participate, we must meet this requirement.

Timely response is an essential part of doing business in this area. This includes proposals, service requests and product information as well as delivery of equipment and installation of equipment. Further, the cost of some products is higher than competition permits.

V. PROPOSED PLAN

The proposed corrective plan is directed toward the two chief deterrents to increased sales, timely response to customer needs and improvement of competitive position.

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A. Mode of Operation

Several changes in the current mode of operation are recommended, these are:

- Standardization of system designs to meet immediate needs of commercial industry customers.
- Standardize estimating and proposal tools to permit rapid response to bid requests.
- Centralize operations for estimating and application of standard system orders within the Marketing Department.
- Sales Philosophy
  - Discontinue sales agreements with outside representatives
  - Expand sales staff to cover Commercial Industry.
  - Emphasize system sales to Commercial Industry
  - Continue hardware sales to Railroad customers
  - Promote system sales to Railroads if and when their own staffs become over burdened and railroad labor agreements permit
- Expand inventory stocking program to include a full compliment of detailed materials required for both system and SP&E orders.

B. Cost Reduction

Secondly, and concurrent with "A" above, several products should be considered for cost reduction in order to place us in a better competitive position. These include:

AFO-II

Motion Monitor

Gate Mechanisms

Gate Arms

Signals

Signs

Wired Cases

Relays

Details of the possible cost reductions are contained in the Appendix portion of this report.

C. Mfg. Facilities Relocation

As a result of the individual product analysis, it is evident that a reduction in the overhead costs is necessary in order to sufficiently reduce individual product costs. Further, an increase in volume of highway crossing products is certain. Department 340, where presently located, does not have sufficient space or facilities to handle increased volume. In addition, over 75% of the parts which are assembled there are made in the Building 10 complex and then transported to Department 340 by electric or walkie truck. It is recommended that Department 340 be relocated in a presently vacant area in the Building 10 complex. Two alternates are presented for consideration and are discussed in detail in Section IV of this report.

Compatible statement ★

While this recommendation represents the largest expense to the Division, it also will produce the greatest results:

★ what would be the OH rates for 2X or 3X volume?

- Lower Direct Labor Costs
- Lower Departmental Overhead Costs
- Lower Variable Overhead Costs
- More Efficient Material Handling
- More Efficient Storeroom Facilities
- Decreased Production Times
- Faster Delivery at Lower Costs

D. New Product Requirements

Several product deficiences currently exist in the highway crossing product line.

Three existing products should undergo a re-design for cost reduction and compatibility purposes. Present design of these products appear to be unsatisfactory to the railroad industry.

Also in order to be a full line supplier, several new products are needed.

Development programs have been identified as follows:

- 12 inch light unit (New)
- Cantilever signal (New)
- Junction box crossarm (re-design)
- Gate mechanism (re-design)
- High current battery charger (New)
- Motion monitor (re-design)

- Solid State flasher (New DV71407)
- Solid State logic unit (New) — for what year?

E. Installation Capability

The recommended plan calls for the following expansion of our installation capabilities:

- Set up one crew working out of Swissvale to handle commercial industry installation as well as railroad installation in this area.
- Establish an operation in the Southeast to serve that area.
- Expand capabilities as future needs dictate.
- Equip crews with modern equipment for efficiency.

why ~~might~~ establish - why not hire or form consortium?

By expanding and equipping our installation crews and concentrating on installation for commercial industry, we will be more prepared for the larger installation requirements by the railroads when they become available. Only 2 railroads (SCL and Southern) are letting installation contracts at this time. However, due to quantity, it is expected that others will follow in the near future. It is anticipated that by better equipping and expanding our capability, we will be able to participate on the SCL and Southern.

details - who?

? who selects products! - (RR)

VI. ACTION PLAN

An agressive action plan has been outlined along with all estimated costs for implementation. The plan includes:

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- Expansion of the Marketing Department.

  Included in this is the setting up of the Highway Crossing Center which would then coordinate all business associated with the Highway Crossing area.

- Develop Proposal and Estimating Tools

  This would be a function of the Highway Crossing Center.

- Develop Standard System Design

  Again, a function of the Highway Crossing Center, with support from the Engineering Department. We would concentrate, first, on standard systems for the industrial area, in order to establish our standard system facilities and component inventory. We would then be in a better position to handle the railroad systems business when it becomes available.

- Initiate Cost Reduction Programs

  Again, coordinated by the Highway Crossing Center.

- Establish New Product Development Programs

  These will be defined and specifications finalized during Phase I of the Highway Crossing Center operation.

- Prepare Promotional Literature

  -Establishing the Highway Crossing Center

  -Promote standard systems capability to industrial customers.

- Complete Service Manuals

  We are a way behind in this area.

- Establish & Expand our Installation Capability

  -During Phase I of the Highway Crossing Center operation.

- Relocate Mfg. Facilities

  -Move Department 340 to Building 10 complex.

VII. PROJECTED COSTS

During the period of this study it was not feasible to develope all cost data; however, most of the near term costs have been identified.

1. Marketing Department Expansion

Organizational Set-up	$132,000
Future Expansion (1-2 years,or as req'd)	70,000

2. Standardization

(When done as a part of the Highway Crossing Center operation.) 9,500

3. Cost Reduction of Existing Products $ 31,000

4. Mfg. Facilities Relocation $406,000 to $521,000

5. New Product Requirements

   (a) Existing DV Programs to be continued

   - Solid State Flasher (DV71407)
   - Solid State Logic Package (DV73501-Feasibility Study)

   (b) New DV Programs Required

   - 12 inch Light Unit
   - Cantilever Signal
   - New Gate Mechanism
   - High current rectifiers
   - Solid State Logic Package

Costs of new product programs to be determined after design specifications are finalized. This will be a function of the Highway Crossing Center Phase I operation.

VIII. PROJECTED WABCO SHARE

In 1974, with a total Railroad and Industrial potential of $55 million, we should be doing a $5.5 million Highway Crossing business (10%).

Can we project How many gates, ATO, mm + code make-up this?

In 1975, with a total Railroad and Industrial potential of $79.5 million, we should be getting approximately $8.0 million, or 10%.

In 1976, with a total Railroad and Industrial potential of $79.8 million, we should be getting approximately $12.0 million, or 15%.

These figures could increase considerably if the Railroads go to a systems business during this period.

not for product. ?

Do we want to be a labor contractor?

IX. SUMMARY

On June 1, 1973, the Study Team was given the objective "to establish Highway Crossing as a product base for the Division". In order to accomplish this objective the team was charged with the responsibility of evaluating all existing concepts and programs and recommend any re-definition of these in order to achieve the objective. We believe the

proposed plan recommended in this report accomplishes this task with a minimum investment. We, therefore, recommend its implementation immediately.

FINANCIAL SUMMARY

PHASE I & II	EST. COST	EST. SAVINGS	ANNUAL R.O.I. %
MKTG. EXPANSION	$131,800	-	-
STANDARDIZATION	9,500	-	-
COST REDUCTIONS	30,853	$86,596	-
NEW PRODUCTS	96,000	132,400	-
MFGRG FACILITIES #1 (A)	521,800	60,000	-
MFGRG FACILITIES #2 (B)	406,800	60,000	-
TOTAL W/MFGRG. FAC. (A)	$789,953	$278,996	35% *
TOTAL W/MFGRG. FAC. (B)	$674,953	$278,996	41% *

PHASE III			
MKTG. EXPANSION (CON'T)	$115,800		-
MKTG. EXPANSION (NEW)	70,700		-
COST REDUCTIONS	-	$86,596	-
NEW PRODUCTS	-	132,400	-
MFGRG. FAC. SAVINGS	-	60,000	-
UNRECOVERED COST-FAC. (A)	510,957	-	-
UNRECOVERED COST-FAC. (B)	395,957	-	-
TOTAL W/MFGRG. FAC. (A)	$697,457	$278,996	40% *
TOTAL W/MFGRG. FAC. (B)	$582,457	$278,996	47% *

FINANCIAL SUMMARY CONTINUED

PHASE I, II, III COMPLETION	EST. COST	EST. SAVINGS	ANNUAL R.O.I. %
MKTG. EXPENSE (ROUTINE)	186,500	-	-
COST REDUCTIONS	-	86,596	-
NEW PRODUCTS	-	132,400	-
MFGRG. FAC. SAVINGS	-	60,000	-
UNRECOVERED COST-PHASE III-(A)	418,461	-	-
UNRECOVERED COST-PHASE III-(B)	303,461	-	-
TOTAL W/MFGRG. FAC. (A)	$604,961	$278,996	46% *
TOTAL W/MFGRG. FAC. (B)	$489,961	$278,996	56% *

* Based on current sales level, does not reflect increased business.

COST REDUCTION

PROGRAMS	COST	SAVINGS PER UNIT (INV. LEVEL)	ANNUAL UNIT SALES	ANNUAL RETURN (DOLLAR)	ANNUAL RETURN (PERCENT)
AFO-II	$3,000.	$ 34.75	50	$1740.	58%
MM-10	7,500.	-	NEW	-	-
AL-70 (GATE MECH.)	10,370.	156.39	280	43,790.	422%
HEAVYWEIGHT MECH.	3,000.	115.97	300	34,791.	1159%
GATE ARMS	1,200.	21.34	375	800.	67%
SIGNALS	3,600.	6.36	335	2,137.	59%
SIGNS	775.	20.18	100	2,018.	260%
WIRED CASES	1,200.	44.00	30 (EST.)	1,320.	110%
RELAYS	208.	- (ALREADY IMPLEMENTED BY MFG. DEPT.)			—
TOTAL	$30,853	$398.99		$86,596	280%

NEW PRODUCTS

PROGRAMS	PROJECTED COST	PROJECTED ANNUAL UNIT SALES	PROJECTED PROFIT PER UNIT	PROJECTED ANNUAL RETURN (DOLLAR)	PROJECTED ANNUAL RETURN (PERCENT)
12-INCH LIGHT UNIT	$20,000.	800	$ 15.	$12,000.	60%
CANTILEVER SIGNAL	14,000.	100	550.	55,000.	392%
NEW GATE MECH.	17,000.	400	156.	62,400.	367%
HIGH CURRENT RECT.	15,000.	150	20.	3,000.	20%
SOLID STATE LOGIC UNIT	30,000.	-	-	-	-
TOTAL	$96,000		$741	$132,400	137%

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HIGHWAY CROSSING STUDY

I. INTRODUCTION

A study team was established, effective June 1, 1973, for the purpose of investigating ways and means of establishing Highway Crossing as a product base for Division. The team is charged with the responsibility of evaluating existing concepts and programs and recommend any redefinition of these programs; further, to investigate and re-evaluate all aspect of the product line and make further recommendations based on these results in order to achieve the objective.

Total Strategy includes getting Safety Standards upgraded — DOT/AAR etc.

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II. STATEMENT OF THE PROBLEM

Sales in the Highway Crossing area has declined steadily over the past several years. The graph (Exhibit No. 1) reflects the picture at a glance; the market size is progressively increasing, while WABCO's share has progressively declined over the past 6 years. We have deteriorated from 27% ($1.7 million) of a $6.3 million total market in 1963 to 9.3% ($1.4 million) of a $14.9 million total market in 1972.

The WABCO share figures do not include relays ordered on SP&E orders. Based on the RSC figure of 1531 crossings installed in 1972 and using an average of 10-15 relays per crossing, another $1.1 to $1.6 million can be added to the WABCO market share. This would increase our total market share to $2.7 to $3.0 million, or approximately 16-18%.

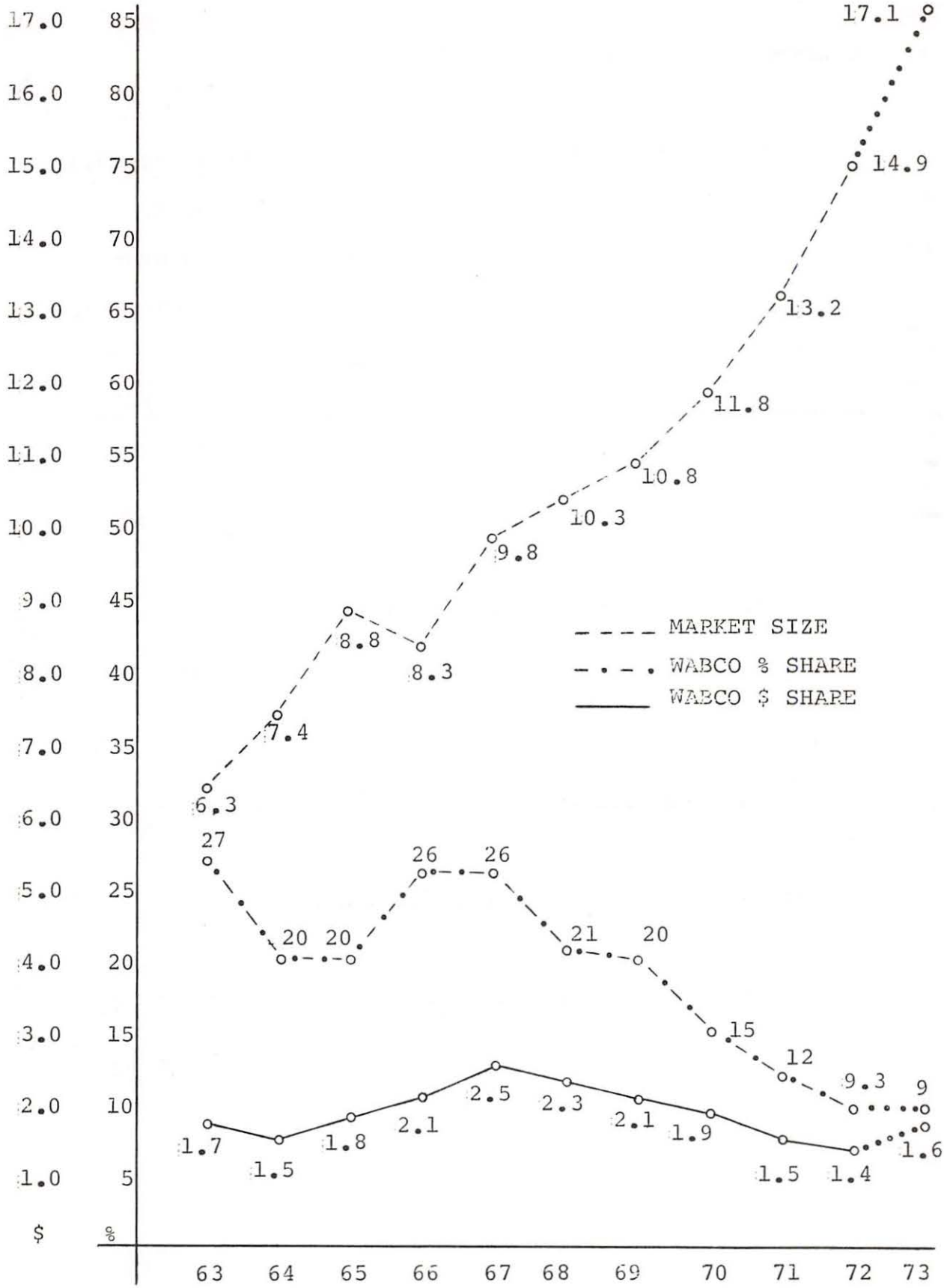

EXHIBIT 1. MARKET SHARE ANALYSIS FOR 10 YEAR PERIOD 1963-1973

III. METHOD OF APPROACH

A. Study Team

1. Composition

The team assigned the task of finding a solution to the problem included the following personnel:

Marketing Dept.	D. F. Remaley
Manufacturing Dept.	J. R. Phelan
Systems Engineering	D. E. Stark
Systems Engineering	E. F. Leonard

2. Assignments

a. Marketing Area

D. F. Remaley and E. F. Leonard were assigned the task of investigating all phases of the marketing and sales areas of the highway crossing market.

b. Product Area

D. E. Stark and J. R. Phelan were assigned to investigate the products and hardware in the highway crossing market.

B. Survey of Business Area

1. Customer Needs

Customer needs were already generally known from previous studies and reports issued as far back as 1967. A survey of five (5) major railroads was made for the purpose of verifying and up-dating the information.

Those customers included in this survey were:

Southern Pacific	R. C. Nagel, Signal Engineer
Burlington Northern	C. H. Dunn, Dir. Sig. Engineer
Union Pacific	E. A. Krause, Gen. Signal Engineer
AT & SF Rwy.	O. C. French, Supt. Signal Systems
Seaboard Coast Line	R. D. Liggett, Ch. Engineer C&S
	R. B. Waterman, Asst. Ch. Engr. C&S
	H. M. Davis, Asst. Ch. Engr. Sig.

2. Competition

In conjunction with the survey of customer needs, a review and evaluation of the competition was also made. This evaluation was made not only on a product price basis, but also from a supplier performance standpoint in order that we could evaluate WABCO's performance in the following areas:

a. Delivery

b. Price

c. Product Acceptability

d. Product Documentation

e. Bid Proposals

f. Installation Capability

g. Product Support

3. Market Analysis

a. Potential Market

(1) Railroad Industry

17 mil 1973 = 1200 - 1500 xings
∴ 34 mil 1974 = 3000 xings

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The potential market for highway crossing business looks very attractive for 1974, 1975 and 1976 compared to the potential market for the past several years. However, a good share of this potential market is contingent upon final legislation which offers funds to be appropriated out of the Highway Trust Fund for installing protective devices at rail highway grade crossings. From the latest source of information available*, it appears that $75,000,000 could be available to the Railroad Industry by June 31, 1974 and $112,500,000 for each year of 1975 and 1976. The 1972 D.O.T. Report to Congress suggests that 3,000 grade crossings should be improved each year over a ten year period. Pending funds allow for 3,000 crossings in 1974 and 4,500 crossings for each year of 1975 and 1976. The 12,000 grade crossings mentioned above represents approximately 40% of the 30,000 grade crossings suggested for improvement within the next ten years (1974-1984). Based on the D.O.T. Report to Congress the average cost per crossing is approximately $25,000. See Exhibit No. 2 for cross-reference computations.

For protection only? — How about separation?

what's the source?

Even though the above mentioned federal funds will be available, it is not expected that the railroads will be in a position to utilize the total amounts in any given year. This funding allows for 3000 crossings in 1974 and 4500 crossings each in 1975 and 1976. More realistic figures appear to be in the neighborhood of 2000 in 1974, 2500 in 1975 and 3000 in 1976. Further, it appears that the D.O.T. average figure of $25,000 per crossing is somewhat high due to the tendency to inflate costs for government funded projects. More realistic figures in this area appear to be as follows:

Control & Sig. Equipment	$5000 - $15000	Avg.	$10,000
Commercial Material	$2000 - $ 4000	Avg.	$3,000
Installation Labor (Customer)	$2000 - $ 7000	Avg.	$4,500
Design Engr. & Services	$2000 - $ 3500	Avg.	$2,500
TOTAL	$11000 $29500	Avg.	$20,000

In view of these figures Exhibit No. 2 in the report should be obsoleted and Exhibit No. 2A, herewith, substituted in its place.

POTENTIAL MARKET AND WABCO DOLLAR SHARE FOR RAIL-HIGHWAY CROSSING INSTALLATIONS

	YEAR	POTENTIAL MARKET EQUIPMENT	POTENTIAL MARKET INSTALLATION	TOTAL MARKET	WABCO DOLLAR SHARE EQUIPMENT	WABCO DOLLAR SHARE INSTALLATION	TOTAL DOLLAR SHARE
RAILROAD INDUSTRY	--1974	$56,000,000	$19,000,000	$75,000,000			
*Less 12% (Approx.)		-7,000,000					
Control Case and Signal Equipment		$49,000,000			$ 4,900,000	$ **	$ 4,900,000
COMMERCIAL INDUSTRY	--1974	$ 4,000,000	$ 2,000,000	*** $ 6,000,000	400,000	$200,000	600,000
Total					$ 5,300,000	$200,000	$ 5,500,000 (Approx. 10%)
RAILROAD INDUSTRY	--1975	$83,500,000	$29,000,000	$112,500,000			
*Less 12% (Approx.)		-10,000,000					
Control Case and Signal Equipment		$73,500,000			$ 7,350,000	$ **	$7,350,000
COMMERCIAL INDUSTRY	--1975	$ 4,000,000	$ 2,000,000	*** $ 6,000,000	400,000	$200,000	$ 600,000
Total					$ 7,750,000	$200,000	$7,950,000 (Approx. 10%)
RAILROAD INDUSTRY	--1976	$83,500,000	$29,000,000	$112,500,000			
*Less 12% (Approx.)		-10,000,000					
Control Case and Signal Equipment		$73,500,000			$11,025,000	$ **	$11,025,000
COMMERCIAL INDUSTRY	--1976	$ 4,200,000	$ 2,100,000	*** $ 6,300,000 (5% Increase over 1975)	630,000	$315,000	945,000
Total					$11,655,000	$315,000	$11,970,000 (Approx. 15%)

* -- Indicates material railroads will purchase from other suppliers such as batteries, cable, concrete foundations, etc.

** -- Indicates installation labor costs not shown, which will be absorbed by railroad labor forces. See inst'l under potential market.

*** -- Estimated on the basis of competitor's market.

EXHIBIT NO. 2

	POTENTIAL MARKET			WABCO SHARE		
Railroad Industry	1974	1975	1976	1974	1975	1976
Control & Signal Equip.	$20.0M	$25.0M	$30.0M	$4.0M	$6.2M	$9.0M
Commercial Material	6.0M	7.5M	9.0M	-	-	-
Installation Labor	9.0M	11.3M	13.5M	-	-	-
Design Engr. & Services	5.0M	6.3M	7.5M	-	-	-
	$40.0M	$50.1M	$60.0M	$4.0M	$6.2M	$9.0M
No. of Potential Crossings	2000	2500	3000			
Commercial Industry						
Control & Signal Equip.	$1.0M	$1.2M	$1.4M	$.2M	$.3M	$.4M
Commercial Material	.5M	.6M	.7M	-	-	-
Installation Labor	.9M	1.0M	1.2M	.1M	.1M	.2M
Design Engineering & Services	.3M	.4M	.5M	.1M	.2M	.3M
	$2.7M	$3.2M	$3.8M	.4M	.6M	.8M
No. of Potential Ind. Crossings	250	300	350			
Totals	$42.7M	$53.3M	$63.8M	$4.4M	$6.8M	$9.8M

Exhibit No. 2A

market for commercial industry can be as high as $6,000,000.

b. WABCO Dollar Share

(1) Railroad Industry

WABCO's total dollar share of the total railroad industry is projected to be 10% ($4.0M) in 1974, 12.4% (6.2M) in 1975, and 15% ($9.0M) in 1976.

~~1976~~. This does not include installation since our survey indicates that the majority of railroads will continue to do their own installation. However, some have expressed their desire to let bids for installation when the workload exceeds their capacity. Two railroads (SCL and Southern) are already doing so.

(2) Commercial Industry

WABCO's total dollar share of the commercial market is projected to be 15% ($0.4M) in 1974, 18% ($0.6M) in 1975, and 20% ($0.8M) in 1976.

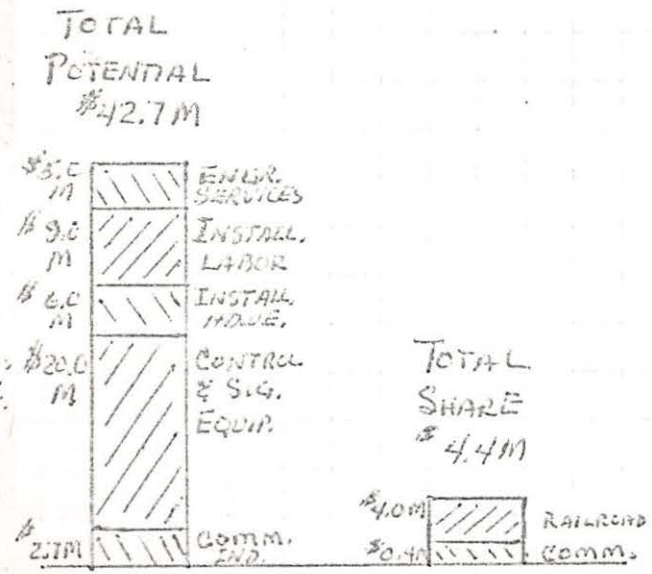
~~1976~~. It is conceivable that this could increase considerably since the Occupational Health and Safety Administration (O.H.S.A.) is applying considerable pressure to commercial industries for more crossing protection.

(3) Total Market Share

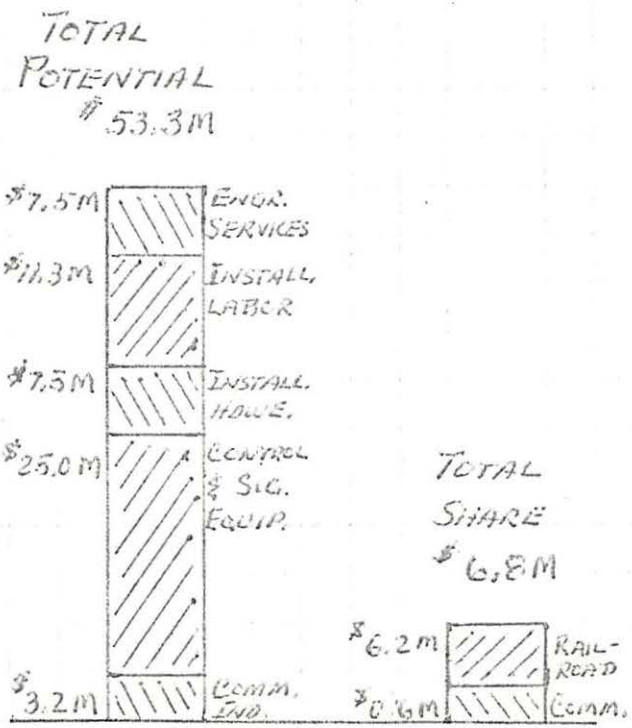
Our total market share, including both industries, is projected to be approximately $4.4 million in 1974, $6.8 million in 1975 and $9.8 million in 1976, if the plan presented in this report is implemented.

~~sented in this report is implemented.~~

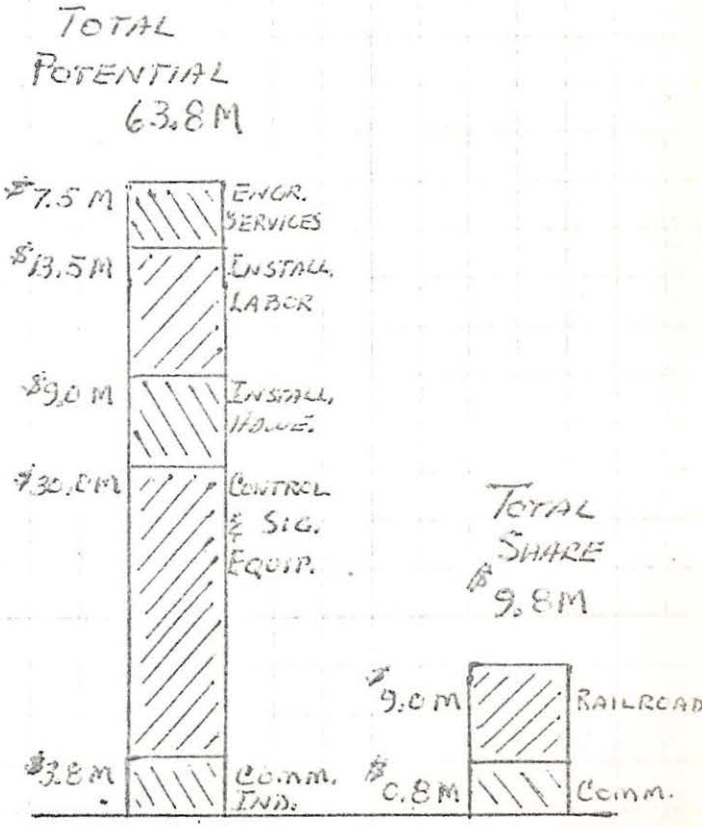
POTENTIAL MARKET & WABCO DOLLAR SHARE



1974



1975



1976

EXHIBIT No. 3A

Exhibit No. 3 reflects Total Potential Market and WABCO Dollar Share.

c. Equipment and Installation Costs

The information shown below indicates cost figures taken from the P.U.C. OF Oregon Report of April 10, 1973, for the purpose of establishing up-to-date costs of materials and installation for various types of highway crossing protective devices. A copy of the Oregon Report is included in the appendix.

Highway Crossing Protective Systems

Standard track circuit train detection plus 2 flashing light signals (no automatic gates (non-signal territory).	Material--	$11,415
	Labor--	3,780*
	Total--	$15,195
Standard track circuit train detection with timeout devices plus 2 flashing light signals and gates (1-track) ABS system.	Material--	$23,470
	Labor--	7,555*
	Total--	$31,025
Motion detection with wrap-around track circuits plus 2 flashing light signals and gates (1-track) ABS system.	Material--	$20,525
	Labor--	7,555*
	Total--	$28,280

NOTE: All railroads involved in the Oregon Study (BN, SP and UP) indicated that wrap-around track circuits were provided with motion detection on main lines.

* Railroad equipment installation costs do not reflect our profit margin.

WABCO

How many Gates, lights, AFO, MM, cases + relays + rectifiers in this price?

d. Average Cost Per Highway Crossing Installation (Automatic Gates)

	Material	Installation	Total
Railroad Industry	$18,470	$6,296	$24,766

The total average cost per crossing as shown above for the railroad industry, which reflects the figures of the P.U.C. of Oregon Report is very close to the $25,000 cost figure suggested by the 1972 D.O.T. Report to Congress.

Commercial Industry	$ 7,300*	$3,500	$10,800

Equipment and installation for one crossing for Commercial Industry is based on providing two (2) auto-gate signals, one (1) area warning track circuit, including commercial material such as batteries, cable, foundations, etc. The data to support the average cost of Commercial Industry equipment includes our* present selling cost of equipment.

C. Evaluation of Products

Another important phase of the study team's effort involved the evaluation of individual products and their design, in the highway crossing business area. Each product was examined separately with emphasis on the following areas:

1. Delivery

SOURCE--Documented report of investigation conducted on April 10, 1973, by PUC of Oregon, which involved 3 major railroads (BN, SP & UP). The purpose of the hearing was to acquire information relative to costs of railroad-highway grade crossing installation and maintenance.

2. Cost

   (a) Design

   (b) Materials

   (c) Manufacturing

   (d) Areas of Potential Improvement

       (Cost Reduction)

3. Acceptability

4. Areas of Potential Improvement

   (a) Cost Reduction

   (b) Product Acceptability

5. Documentation

D. Assumptions

In order to properly analyze and evaluate this business area, certain basic assumptions were made. These assumptions, naturally, were carefully considered in the "Recommendation" portions of this study.

These assumptions include:

1. Government subsidies to the railroad industry for the installation of crossing protection will continue, thereby resulting in a continual increase in the market area over the next 10 years.

2. There will be no major change in the method of detecting and indicating the presence of trains approaching a grade crossing. The industry will continue to use track oriented train detection methods and visual warning devices.

WABCO

3. There will be no quantum change in grade crossings versus grade separation.

2 Pg III-3

4. It will continue to be company policy to market products and systems designed and manufactured to the same high product reliability and "Failsafe" standards, where practical.

5. The railroad industry will continue to specify the type of equipment and systems required. ☆

6. O.S.H.A. will continue to apply pressure on the commercial industry to install crossing protection on their property.

☆ No mention of legal ramifications which force the method of procurement.

IV. ANALYSIS, DEDUCTIONS AND RECOMMENDATIONS

The highway crossing business area has been reviewed on several previous occassions. In general, these previous efforts attacked specific areas of equipment design, performance or operational needs. The current task force has taken a much broader approach so as to permit an overall analysis of the needs of the highway crossing business area.

Very early in this review certain factors became apparent as deterrents to the saleability of our highway crossing product line. It was further recognized that it would not be possible to implement corrective action on all areas of the product line during the brief period of the study. Efforts, therefore, have been concentrated on the task of defining potential areas where improvements may be expected to have significant impact on saleability and profitability.

This section of the review has been divided into four areas: the Non-product (services) area, the Existing Product area, the Manufacturing Facilities area and the New Product Requirement area.

A. Non-Product (Services)

1. Delivery

a. Analysis

The outstanding single factor which inhibits the sale

of our equipment is the long and unpredictable delivery time which we have historically required for equipment and systems shipments. The true needs of our customers have been determined to be in the range of thirty days for shipment of all equipment. The reason for this requirement is established by the demands of the governing bodies, the regulatory agencies and the public in general.

Delivery problems are the direct result of in-plant order handling as well as inventory. Since we are talking about two different types of orders (SP&E and system), they will be dealt with separately.

1. SP & E Orders

A review of this area revealed that where the items were in inventory, shipment within 30 days presented no problem. However, for those items not in stock the delivery time is extended depending on the lead-time for manufacture of the particular item. In most instances this time is extended to 90 days or more. Obviously, this time is unsatisfactory.

There are many reasons for items being "out of stock". For example

(a) Large SP&E orders deplete stock.

(b) Inadequate stock forecasting.

(c) Insufficient stock of components and raw material.

(d) Large high priority Non-Highway Crossing system orders.

2. System Orders

The present program for processing customer orders in the highway crossing area provides for two methods of order handling.

Method #1 (Exhibit 4)

A limited number of pre-wired control cases covering a few standard crossing arrangements are maintained in stock. If an order is received which fits one of these standard arrangements, shipment can be made within 30 days, as shown in Exhibit 4.

Method #2 (Exhibit 5)

If, however, an order is received which does not fit one of the standard arrangements, the delivery time is presently extended to 90 days or more, as shown on Exhibit 5. This is due mainly to the fact that the component parts required to complete the wired case are not available from stock, therefore, the full manufacturing lead times for the components parts prevail. These lead times are anywhere from 60 to 120 days.

Investigation showed that several of the pre-wired cases that were placed in stock have not "turned over" in the past 3-4 years. Some of these have recently been

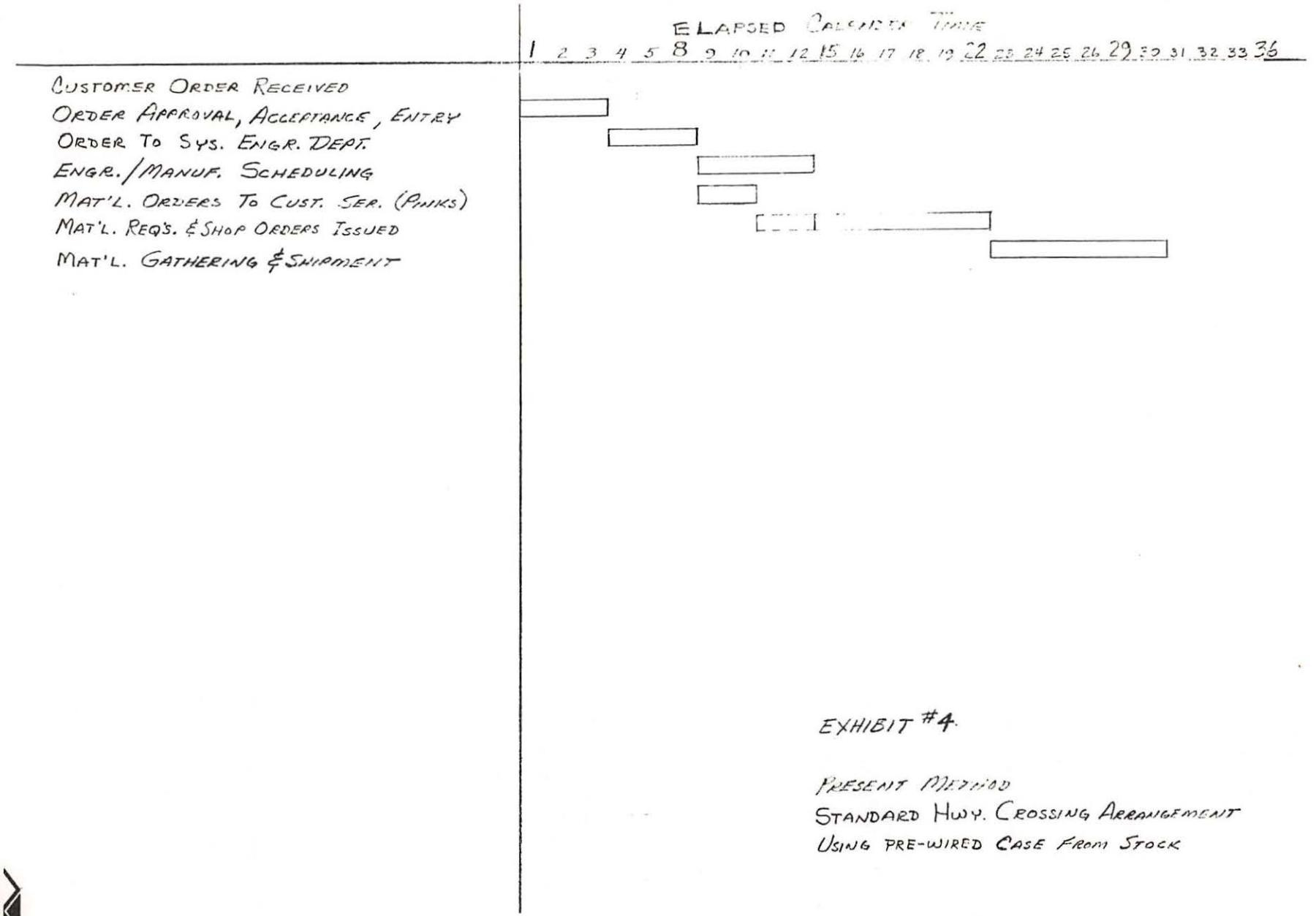


EXHIBIT #4

PRESENT METHOD
STANDARD HWY. CROSSING ARRANGEMENT
USING PRE-WIRED CASE FROM STOCK

WABCO

dismantled and the component parts returned to stock.

Further, as shown on Exhibit 4 the lapsed time from the time a purchase order for a highway crossing system is received until it reaches the engineers desk for handling is normally 6-8 days. Another 4-8 days are required for finalizing engineering/manufacturing schedules, after which material orders will be acted upon by Customer Service Dept. Normally another 6-8 days are required to process the material orders and issue shop orders and material requisitions. These times are based on the use of a standard crossing arrangement using a pre-wired case from stock and do not include circuit or wiring diagram preparation time. This time is extended considerably when these facilities are required, as shown in Exhibit 5. The times shown in Exhibits 4 and 5 are based on randomly selected case histories of system orders received over the past year.

b. Deductions

(1) Highway Crossing is a 30 day delivery business area for routine SP & E orders as well as system orders. We must accept this fact and respond accordingly if we expect to obtain a respectable share of this market.

(2) Stocking of pre-wired cases for standard highway crossing arrangements is neither practical nor economically feasible.

More than 70 possible standard arrangements have been identified, excluding individual customer standards.

(3) Order handling time from "receipt of order" to "start of manufacture" is not geared to handle 30 day shipment of highway crossing system orders. Order handling normally requires 16-24 days, however, it can be as much as 30 days when the requirement deviates even slightly from a standard system.

(4) Only a relatively small quantity of the standard crossing arrangements have been standardized, thereby requiring regeneration of the same circuit and wiring diagrams for each application. This also has an adverse effect on estimated project costs, since engineering time must be included in each estimate.

c. Recommendations

From the analysis of our past performance it appears that improvements in several areas are in order for better overall output performance.

There is a need for better methods of controlling the overall operation and speeding up the handling of routine requests for bid proposals and customer orders.

Therefore, the following action is recommended:

(1) Standardization

A sufficient number of standard systems must be designed and entered on file to meet our anticipated requirements. In the neighborhood of 70 different standards are possible however, only approximately 25 will be designed during Phase I. The remainder must be re-evaluated before a decision can be made on which arrangements should be standardized, therefore, costs for these have not been included.

Each design should be complete with circuit schematics, wiring diagrams and bills of material.

These standard designs will also aid the salesman and will ultimately result in establishing better control and definition of inventory.

(a) Projected costs for engineering of systems and development of standard drawings.

Engineering and development of standard drawings for 25 systems will require engineering support from four sections. The basic design of each system will be a joint effort between the Highway Crossing Center and System Engineering Signal Section.

(1) Wiring Diagram Section

Wiring diagrams complete:

Time	Total Estimate Cost
2-1/2 months	$2100 (DL)

(2) Circuit Drafting Section

Circuit schematics complete:

Time	Total Estimate Cost
2 months	$1300 (DL)

(3) Mechanical Drafting Section

Bills of materials and computer time:

Time	Total Estimate Cost
3-1/2 months	$3500 (DL)

(4) Signal Engineering Section

Engineering of Highway Crossing systems:

Time	Total Estimate Cost
2 months	$2400 (DL)

(2) Highway Crossing Center

Establish a Highway Crossing Center operation as a central point with responsibility and authority to control and monitor all the functions related to the highway crossing business. A recommended plan of action for developing the Highway Crossing Center is outlined in Appendix XI.

(3) Inventory Stocking

Since our manufacturing facilities are not geared to respond to 30 day delivery of S.P. & E. orders, it is imperative that inventory be maintained at a sufficient level to support the market. A step in this direction was taken this past May when a partial inventory list covering highway crossing equipment was prepared and approved. This, however, will be continuously monitored by the Highway Crossing Center function with inventory levels being adjusted accordingly based on market forecasts.

Eliminate stocking pre-wired cases for systems. This method is neither practical nor economically feasible in view of the wide variety of standard arrangements required. Instead, stock all component parts required to complete any type of standard highway crossing arrangement and build systems on an "as ordered" basis.

good

(4) Warehouse Facility

A warehouse facility in Southeastern U.S.A. would be advantageous for "off the shelf" delivery of hardware items similar to the San Leandro operation.

— also consider Kansas City —

Inventory stocking problem

(5) Early Action on System Orders

Begin action on standard system orders earlier by establishing a means for getting information to manufacturing immediately (5 days ARO).

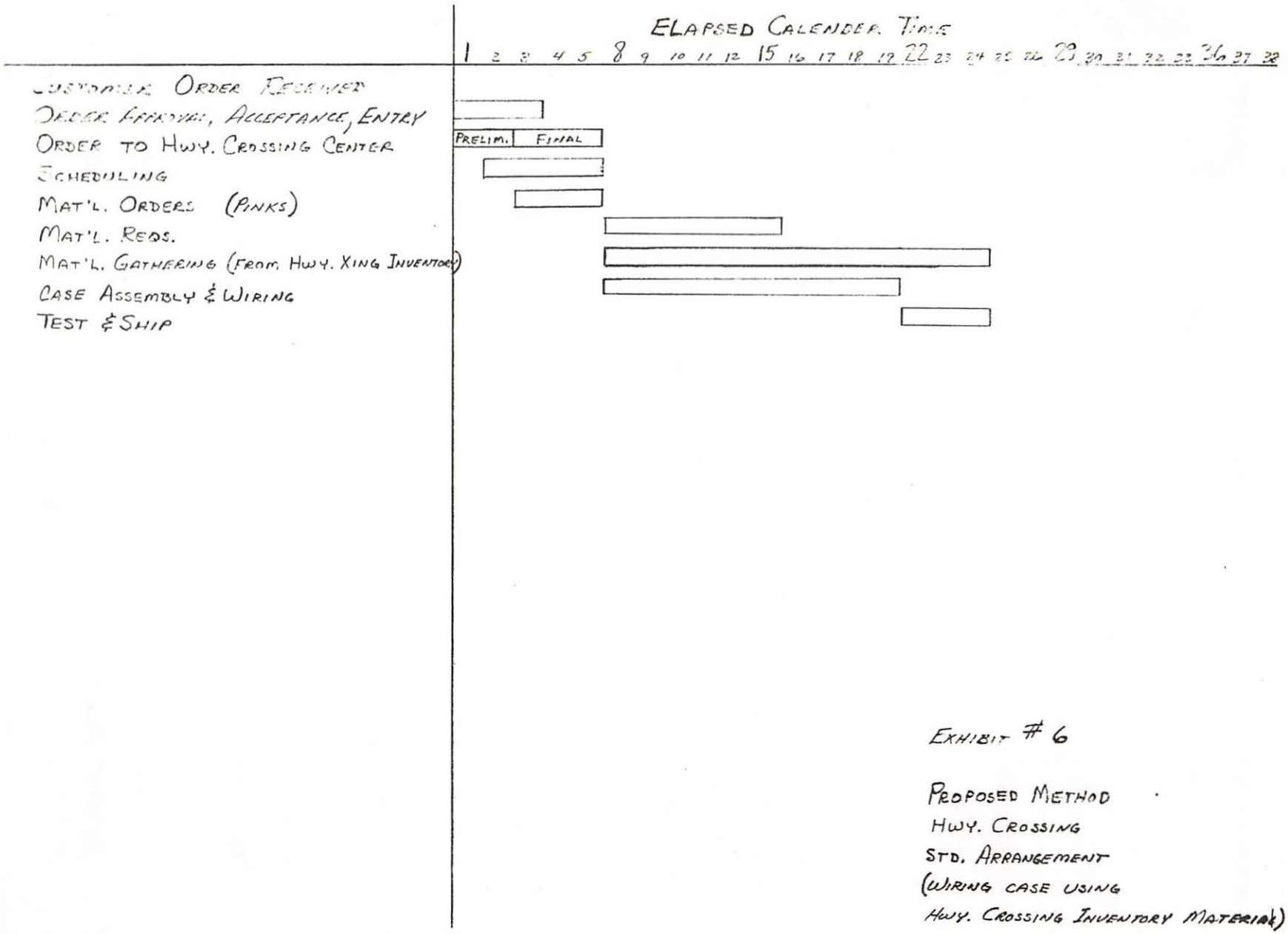


EXHIBIT # 6

PROPOSED METHOD
HWY. CROSSING
STD. ARRANGEMENT
(WIRING CASE USING
HWY. CROSSING INVENTORY MATERIAL)

WABCO

Begin action immediately upon approval of the order by Marketing. See Exhibit 6. Also by establishing a means for modifying standard arrangements, orders requiring minor alterations to a standard system can be shipped within 30 days.

2. Price

a. Analysis

The following information is related to the price structure of our products and systems for highway crossing equipment.

(1) Exhibits 7 and 8 reflect a tabulated cross reference of competitive prices for similar products and equipment. Some competitive prices are not available due to our lack of reliable competitive intellegence.

(2) The cross reference indicates that our prices are generally higher than Western-Cullen, Safetran and Harmon who are our strongest competitors in the highway crossing business.

(3) Each product is analyzed in greater detail in the appendix of this report.

(4) A survey of several "Lost Business" files indicate that our high cost of system engineering, and installation and

material costs for highway crossing system packages are significant factors in losing bids.

b. Deductions

(1) Exhibits 7 and 8 indicate a general trend. Our prices are generally higher than those of our competition. By decision

(2) The engineering design content on standard system applications must be eliminated.

(3) Engineering content on non-standard systems should be reduced to a minimum.

(4) Overhead costs contribute substantially to our high selling prices.

c. Recommendations

(1) Each product must be examined from a cost reduction standpoint as outlined in the Appendix of this report.

(2) A library of pre-engineered standard systems must be developed. This is part of the Phase 1 operation of the Highway Crossing Center.

(3) Engineering content on non-standard systems can be reduced by using pre-engineered standard systems as a basis for design.

Equipment	US&S	GRS	Western-Cullen	Safetran	Harmon	Erico
			PRODUCT LINE			
2-Way Flasher Crossarm Junction Box w/Hoods and Backgrounds	$213	$215	$201	$225	$203	-
Crossarm Junction Box Only	80	59	57	?	71	-
Flashing Light Unit Only	41	46	36	40	?	-
SORS Sign	37	34	30	21	26	-
RR Xing Sign	44	56	37	30	?	-
Tracks Sign	32	33	23	19	24	-
Junction Box Base	58	49	54	55	76	-
Bell	103	?	89	83	95	-

NOTE: amounts are shown in dollars

EXHIBIT NO. 7

Equipment	US&S	GRS	Western-Cullen	Safetran	Harmon	Erico
26 ft. Gate arm w/3 lights	2 $258	?	3 $302	1 $209	?	-
AFO-modulated Transmitter-	3	4			1	2
High Power	369	540	-	-	292	302
Low Power	341[4]	375[5]	-	184[1]	222[2]	240[3]
Receiver	341[4]	275[1]	-	307[2]	400[5]	310[3]
Motion Detection Unit	780[2]	-	-	*1456[4]	737[1]	*795[3]

* = With Broken Rail Protection

SUB-SYSTEMS

2-Way Flasher signal complete	390[4]	410[5]	367[3]	358[2]	345[1]	-
Control case complete with Type "C" trk. circuits (Plug-In relays)	3290[2]	?	4800[3]	3050[1]	?	?
LW Type Gate Mechanism	984[3]	740[1]	1113[4]	755[2]	-	-

EXHIBIT NO. 8

(4) Following completion of cost reduction of all products as recommended in this report, an examination of margins on each product should be made and prices adjusted accordingly.

(5) Establish and maintain an adequate competitive intelligence gathering system.

/ Dedicated Salesmen do this best

3. Sales Coverage

a. Analysis

(1) Our sales efforts in the past have been concentrated for the most part on the Class I railroads.

(2) Arrangements were made with L.B. Foster Co. to represent us in the Class 2 railroad and commercial industrial areas. This has resulted in only two orders and these were for a special application. Why?

(3) Highway crossing system installation is increasing rapidly in the commercial industrial area. Some 15-20% of the installations made in 1972 were installed by commercial industries such as steel, automotive and chemical who are being motivated by O.S.H.A. Date? Statistics III-4 show commercial share to be 6/15 (8%)

(4) Presently, most Class 1 railroads are purchasing hardware only. They are doing their own engineering and wiring. This is expected to change in the future due to the

increase in the number of systems to be installed, but is subject to negotiation by BRS of A on an individual basis.

(5) Most commercial industrial installations are complete system orders including factory wired cases.

b. Deductions

(1) Our present sales force is not large enough to cover the Class 2 railroad and commercial industrial accounts.

(2) The arrangement with L.B. Foster Co. to represent us in the Class 2 railroad and commercial industrial areas has not proven effective. This could be at least partially due to the fact that L.B. Foster Co. is also a representative for Western-Cullen.

Have they given any $ to us?

(3) Since the commercial industrial area is rapidly growing, we need to expand our sales force to better serve this area. Also by concentrating in this area we will be able to establish our standard systems capability, which in turn, will better enable us to respond to the railroad systems business as it developes.

c. Recommendations

(1) We should discontinue the arrangement with L.B. Foster Company. Instead, we should expand our sales force to

cover the Class 2 and commercial industrial business areas. This should be established as part of the Highway Crossing Center discussed previously.

(2) Once contacts are established in the commercial industrial area, other existing product lines will become marketable such as radio and remote control of locomotives.

(3) Also new hardware products for industry should be introduced such as wheel chocks, derails, etc.

(4) Class 1 sales accounts will remain unchanged, however, emphasis should be directed towards total systems. Support in this area will be provided by the Highway Crossing Center as required.

4. Bid Proposals (Quotations)

a. Analysis

(1) Our present methods of preparing proposals are very inadequate to meet our customers requirements. A survey of several system quotations indicate we exceed a 10 day customer requirement by an additional 10 to 40 days.

(2) Within our organizational structure we lack the proper communications and co-ordinated efforts between departmental functions that are required to develop proposals in a short time period. A considerable amount of time is lost

each time an estimate is transferred to the various departments for processing.

(3) Engineering time and cost is presently included in each estimate due to the lack of sufficient standard designs.

(4) We do not have an adequate system to maintain an up-to-date price list of commercial material required for complete systems. Considerable time is lost waiting for quotations from these sources.

(5) Considerable time is lost obtaining complete information from the customer necessary to make the estimate.

(6) Approximately 10 days are lost by sending the proposal from Swissvale to a district office and then to the customer.

b. Deductions

(1) A faster turn-around time for proposals must be established. All proposals for standard systems must be turned around within 5-10 days, and for non-standard systems within 10-15 days.

(2) Sufficient tools must be established to enable this turn-around time to be achieved, including information gathering, preparation of estimate, pricing information, and

proposal handling.

(3) Engineering design content must be eliminated from standard system applications.

c. Recommendations

(1) All estimates for standard systems will be made entirely within the Highway Crossing Center.

(2) Proposals for non-standard systems will be made by the Highway Crossing Center with estimate support from the Systems Engineering Dept.

(3) As part of Phase 1,establishing the Highway Crossing Center, a series of basic estimating tools will be established and entered into the computer. These can then be extracted at any time thereby providing computerized estimating. The program for this is already in existance, therefore, the only cost involved is establishing the bills of material required.

(4) The establishing of standard systems in Phase 1 of this program will be eliminated the design engineering content in each estimate.

(5) Take steps to provide a means of obtaining more complete field information. There presently exists a specification sheet which is to be completed by the sales

representative with information obtained from the customer. This tool needs to be revised and expanded to include more complete information.

5. Sales Promotion

a. Analysis

(1) Sales Bulletin

This literature is given to prospective customers or used in direct mail service to establish new product awareness.

A program to develop this literature for sales use has been initiated but none have been published to date.

(2) Product Bulletin

This literature includes technical information such as product description, specifications, general application information and ordering references.

Product Bulletins are now available for only approximately 50% of the product line.

(3) Railway Signal Equipment Catalog (RSE10-)

The section of this catalog dealing with highway crossing equipment has recently been up-dated and distributed to our railroad customers.

(4) Oral Product Presentations

Customer oriented presentations for some of our newer products are presently actively pursued as part of the sales promotion program.

This method of promotion provides excellent product sales support as well as an opportunity to challange competitors product claims.

(5) Trade Show Coverage

Various highway crossing products have been displayed at railroad AAR conventions in past years. Emphasis on highway crossing systems in general, however, was very minimal. Commercial industry trade show conventions are not covered.

which was for exposure?

(6) Trade Magazine Coverage

Space advertising for highway crossing products and systems is not used at this time.

Some products have received moderate coverage in various railroad group trade magazines.

(7) General News Coverage

WABCO's position in the highway crossing protection program has received very little coverage in this area.

b. Deductions

(1) Due to a lack of advertising and publicity WABCO has been tagged with a "lack of interest" attitude in the highway crossing market area.

(2) The industrial market area, in many cases, does not know WABCO exists as far as highway crossing area is concerned.

(3) In general, there is a definite lack of definition and support in this area.

c. Recommendations

(1) An ambitious program must be initiated to promote WABCO highway crossing products and systems. The program "kick-off" should be an announcement introducing the new Highway Crossing Center.

(2) One of the functions of the Highway Crossing Center will be to outline and initiate a sales promotion program aimed at expanding our highway crossing system sales in the commercial industrial area, as well as re-establishing our highway crossing image with our present railroad customers.

6. Installation Capability

(a) Analysis

(1) In the past our volume of installation of highway crossing protection systems has been very low.

(2) High cost of installation and low volume business have affected the results of our past performances.

(3) Equipment rental fees as well as excessive travel and living expenses contribute to our high cost of installation.

(4) In some cases our bids run 30% to 50% higher than our competitior.

(5) Other factors which contribute to our poor performance are:

(a) Lack of proper installation equipment.
(b) Shortage of skilled installation manpower.
(c) Lack of de-centralized installation centers.
(d) Lack of information reqarding site conditions.
(e) Lack of sufficient sales coverage to cover a large area of potential customers that need immediate service.

competition is localized —

b. Deductions

(1) We must have installation capability if we consider ourselves a "full line" supplier.

Why?

WABCO

(2) Installation capability is of the utmost importance in the commercial industrial area.

(3) We lack the organized structure with coordinated team efforts designed for highway crossing installation.

c. Recommendations

(1) In order to meet our immediate and long range needs, we must establish within the Phase 1 time period one mobilized crew. — for local work only —

(2) A crew must include the necessary equipment including:

(a) Utility truck equipped with boom lift and vertical auger.
(b) Ditch digging machine.
(c) Horizontal under-road auger
(d) Hand tools

(3) One crew should consist of two men. Additional labor should be considered as temporary and hired as required.

(4) This crew should be assigned out of Swissvale with coordination being provided by the Highway Crossing Center.

(5) As part of the Phase 1 operation of the Highway Crossing Center an investigation should be made into establishing a facility (or facilities) in the Southeast area to handle the Seaboard Coast Line and Southern installation requirements. These could either be satellite facilities of the Swissvale operation or arrangements with a commercial contractor. Further investigation is required in this area before commercial contractors can be recommended.

(6) Other similar remote mobile installation facilities should be established as required. All such facilities should be co-ordinated with the Highway Crossing Center.

7. Summary

We have been unsuccessful in dedicating sufficient resources to the highway crossing market and as a result our present mode of operation is not conducive to timely and competitive response to the needs of the Highway Crossing Market. The keys to our future success in this area are as follows:

(a) Timely response to customer needs, which will be facilitated by centralized control through the Highway Crossing Center operation.

(b) Become cost competitive by standarizing system designs and by cost reducing several key products.

(c) Expand the market to include the commercial industrial and Class 2 railroad areas.

(d) Develop installation capability in order to be able to respond on a timely and competitive basis.

B. Existing Products

It was recognized at the outset that there was a limit to the cost effectiveness which could be achieved from small, nickel/dime, changes in design and procedure. Therefore it was determined that a general review would be made to define the areas where reasonable improvements could be achieved without incurring disproportionate costs in implementation. Several key areas were examined first for gross deficiencies and later for the potential of improvement through multiple, though smaller, changes. Each product is reported separately in detail in the Appendix using similar presentation formats to facilitate review by the reader.

The "cost of changes" was projected by the committee because of the exploratory nature of the investigation and because to request formal estimates through regular channels would have required too much time and over burdened the normal estimating functions of this Division. Where it was feasible quidance was obtained from sources close to the various operations. However, the ultimate responsibility for the "cost of change" data in this report belongs solely to the

committee. Formal estimate commitments of course should be obtained for those items finally accepted for action prior to initiating changes.

Various products are summarized in the following paragraphs. All cost comparisons are made on the basis of direct labor plus purchased material cost.

1. AFO-I

While AFO I has been found satisfactory, at least by a few customers, its continued suitability is dependant upon the nature of the forthcoming AAR Standard criteria for AFO applications. The current DV program which calls for replace ment of the germanium transistors with silicon types should remain in effect thus permitting continued sales of AFO I until industry standards are classified. See appendix I for details.

No other program should be initiated at this time to redesign or up grade the AFO-I product line.

2. AFO-II

Our customers appear to consider the AFO II product acceptable in so far as design and performance are concerned. There is however, an unfavorable price differential which tends to limit the purchase of our product. Some potential cost reductions, as outlined in Appendix II might help to

narrow this differential if it can be established that the modifications will be acceptable to the customer. The maximum potential appears to be about $35 per trans/Receiver pair at the inventory level. Will this give a cost/competitive product?

3. Motion Monitor (MM-10)

Assuming a satisfactory solution regarding handling of application problems a two phase plan should be established as follows:

1. Develop interim application rules for existing MM-10.
2. Initiate a development program for a second generation Montion Monitor. See Appendix III for details.

Dev. competitive price analysis/vs features to help sell unit.

4. Gate Mechanisms

The selling price of both the light and heavyweight mechanisms are slightly higher than competition. The main criticism directed towards these products by customers has been the long delivery times. Some significant cost reductions and lead time improvements, as outlined in Appendix IV, will help to improve both of these situations.

In light of several additional criticism brought forth by the Southern Pacific, and others, concerning certain design aspects, as well as maintenance problems with the present mechanisms, it is recommended that consideration be given to the design of a new mechanism which would replace both the lightweight and heavyweight mechanisms.

For further information concerning the recommended new design refer to the "New Products" section of this report.

5. Gate Arms

Our aluminum gate arms have been accepted very favorably by our customers as far as design & performance are concerned. A significant fabrication change as outlined in Appendix V has the potential of decreasing costs while improving quality as compared to competition.

6. Signals

The HC-100 signal assembly design is not acceptable to all of our customers. Also there is an unfavorable price differential even though this product is priced below cost level. A redesign is needed on this product as outlined in Appendix VI, if we expect to capture our share of the market.

7. Signs

Presently we sell our signs at total product cost level. Evan with this concession our selling price is significantly higher than competition. Some potential cost reductions, as outlined in Appendix VII, could make these products more competitive.

WABCO

8. Wired Cases

The majority of the components used in the wired cases have already been cost reduced. Short of a major design or manufacturing change, it does not appear at this time that the cost of wired cases can be improved. However some minor cost reductions as outlined in Appendix VIII, could improve our product cost.

9. Rectifiers

(a) Develop a statement covering the general philosophy of charging batteries with specific emphasis on minimization of the ill effects of improper methods and the benefits to be gained from our most recent innovation with the automatic two rate charge rectifier CCRA.

(b) Develop a well planned sales approach to take advantage of our position with the new CCRA System.

(c) Expand the product lines to include units with higher output ratings such as 10A, 15A, 20A, 30A, and 40A. All of these, of course, are at 12 volts.

(d) Investigate the effects of cyclic variation in battery voltage and establish a "standard practice" for use of CCRA rectifiers in applications employing equipment which might be sensitive to rapid battery voltage fluctuations.

(e) For more detailed information see Appendix IX.

10. Relays

Our relays are acceptable to our customers as far as design and performance are concerned. However, there is some criticism directed toward our delivery time. Some potential improvements, as outlined in Appendix X, could help to improve this condition. The shelf type relay is most popular with the commercial industry, and should be used for commercial industry applications in so far as possible. The plug-in relay application puts us in a non-competitive postion in the industrial area due to the higher price of the relays.

Study why shelf is less costly than Plug-in? would volume help?

C. Manufacturing Facilities

1. Analysis

As a result of the individual product analysis, it was evident that a reduction in the overhead costs is necessary in order to reduce individual product costs. Further, as a result of the customer survey, an increase in volume of highway crossing products (gate mechanisms, arms, signals, etc.) is certain. Based on past performances it is apparent that we must improve our output capabilities. In view of these facts, a review of the plant layout and its related facilities was undertaken. This review revealed inadequacies in several areas. These are discussed in more detail in the "Deductions" portion which follows:

2. Deductions.

a. Location

Dept. 340, at present, is not satisfactorily located for the assembly type work operations that are involved for highway crossing products. Over 75% of all the detail parts which are assembled in Dept. 340 are routed by machining methods through existing work sections located in the Building No. 10 complex (Depts. 310, 320, 370, 380, etc.). These detail parts then must be transported by electric or walkie type trucks to Dept. 340 for final assembly.

b. Methods

Presently a great deal of time is spent on moving products from one work station to another, and the material flow within the department, including the sub-assemblies is unsatisfactory.

c. Storeroom Facilities (Storeroom 36Y)

Present storeroom facilities in Dept. 340 are inadequate. At times, over 50% of Dept. 340 work area is used for storeroom purposes.

The appearance of some of the inventory housed in 36Y indicates little or no usage. In addition, the bin sizes need to be re-evaluated.

d. Building No. 10 Complex

Adequate space is presently available in this area which would allow one area to be used for the assembly operations for highway crossing products, while the other products which are presently assembled in Dept. 340 could be segregated from the highway crossing equipment, within the available space. This area would be beneficial in several ways for the products involved. Both trucking and railroad facilities are already built into Building No. 10, thus permitting timelier and more efficient shipping and material handling.

Improved assembly techniques could be initiated such as the laying out of assembly type work benches to include overhead or conveyor type material moving equipment and the stocking of miscellaneous hardware such as nuts, bolts, etc. at the bench areas. This would minimize lost time due to improper material flow and material gathering.

3. Recommendations

Immediate consideration should be given to moving all of the present Dept. 340 operations, including Storeroom 36Y, from Building No. 34 to the south end of the Building No. 10 complex which is presently partially occupied by the Welding Dept. The rest of the area is presently vacant.

Herewith for consideration are two relocation proposals (Exhibits 9 & 10) along with estimated costs to implement each proposal.

While each proposal has its own merits, there are other factors, not directly associated with highway crossing equipment, which should be considered in making a final decision.

(1) Building No. 34 is presently in very poor condition and in need of repair. One end is presently supported on jacks. Also present working conditions are not satisfactory in that the roof leaks in numerous places and the lighting is very bad.

(2) Presently the Welding Dept. is located where there is little ventilation and as a result the workers are occasionally subjected to excess smoke and fumes. If production were to increase in the area, this condition could possibly result in a health hazard as well as a working violation.

While these items could be corrected at probable high maintenance costs, Management should investigate to see if monies are in the planning, or are going to be allocated in the near future, for these purposes.

RELOCATE DEPT. 340 & S.R. 36Y FROM BLDG. #34 TO BLDG. #10

I. Conduct study to determine:		
A. Am't of area required & proper layout of benches & equipment for Dept. 340 in Bldg. #10.	$1,800	E
B. Am't of space required for S.R. 36Y to include identifying & disposing of non-active inventory.	5,000	E
II. Relocate Sec. 385 from Bldg. #10 to north end of Bldg. #14		
A. Preparation of Bldg. #14, lighting, ventilation, painting, power lines, etc.	150,000	C
B. Physical Move	20,000	E
III. Relocate S.R. 36Y from Bldg. #34 to Bldg. #10		
A. Purchase & Erect High Stacking storeroom System.	200,000	C
B. Physical Move (Inventories)	10,000	E

EXHIBIT #9 (Sheet 1 of 3)

WABCO

IV. Relocate Dept. 340 From Bldg. #34 to Bldg. #10

A.	New lighting facilities Bldg. #10	$35,000	C
B.	Overhead moving equipment Bldg. #10	15,000	C
C.	New work benches	15,000	C
D.	New test equipment & related Facilities	25,000	C
E.	Physical Move-Facilities	20,000	E
F.	Misc. - Installation of Power Lines & Air, etc.	10,000	E

V. Raze Bldg. #34 15,000 E

Total Expense Exp.	$81,800
Total Capital Exp.	$440,000
Total Esitmated Cost of Move	$521,800

EXHIBIT #9 (Sheet 2 of 3)

WABCO

ESTIMATED SAVINGS FROM MOVE

A. Present Tax Bldg. #34 $4,365

B. (1) Truck Oper. (It is estimated that one elec. trk. oper. is used full time to transport detail parts & sub-assemblies from phase III Sections To Bldg. #34

Savings = 3.52/HR x 1 yr. x 30 Fringe = 9,500

C. Utilities Savings - Bldg. #34 = 4,000

D. Maint. Savings (Heat & Leak Repairs) = 2,000

E. Lower O.H. Costs for Phase III (Total Sq. Footage for Phase III would be reduced by 45,640 sq. ft.) 10,000 - 20,000

F. Expense Reductions

1 Improved Ass'y Time
2 Faster Mat'l Movements 10,000 - 20,000
3 Improved Lead Times

Total Est. Savings/Yr. $39,865 - $59,865

EXHIBIT #9 (Sheet 3 of 3)

WABCO

RELOCATE DEPT. 340 FROM BLDG. #34 TO BLDG. #10 & S.R. 36-Y FROM BLDG. #34 to BLDG. #3.

I.	CONDUCT STUDY TO DETERMINE:		
	A. Am't of area required & proper Layout of benches & equipment for Dept. 340 in Bldg. #10	$1,800	E
	B. Am't of space required for S.R. 36-Y, to include identifying & disposing of any non-active inventory	5,000	E
II.	RELOCATE SEC. 385 FROM BLDG. #10 TO NORTH END OF BLDG. #14.		
	A. Preparation of Bldg. #14, Lighting, ventilation, painting, power lines, etc.	150,000	C
	B. Physical Move - Facilities	20,000	E
III.	RELOCATE S.R. 36-U FROM BLDG. #3 TO 2nd FLOOR - BLDG. #1		
	A. Physical Move - Facilities & Inventories	10,000	E
IV.	RELOCATE S.R. 36-Y FROM BLDG. #34 TO BLDG. #3.		

EXHIBIT #10 (Sheet 1 of 3)

A.	New Racks & Bins	$75,000	C
B.	Physical Move (Inventories)	10,000	E

V. RELOCATE DEPT. 340 FROM BLDG. #34 TO BLDG. #10

A.	New Lighting facilities Bldg. #10	$35,000	C
B.	Overhead Moving Equipment Bldg. #10	15,000	C
C.	New Work Benches	15,000	C
D.	New Test Equipment & Related Facilities	25,000	C
E.	Physical Move - Facilities	20,000	E
F.	Misc. - Installation of Power & Air Lines Etc.	10,000	E

VI. Raze Bldg. #34 — 15,000 E

Total Expense Exp.	$91,800
Total Capitor Exp.	$315,000
Total Estimated Cost of Move	$406,800

EXHIBIT #10 (Sheet 2 of 3)

WABCO

ESTIMATED SAVINGS FROM MOVE

A. Present Tax Bldg. #34 $4,365

B. (1) Truck Oper. (It is estimated that one Elec. Trk. Oper. is used full time to transport detail parts & Sub-Assemblies from phase III sections to Bldg. #34)

Savings = 3.52/HR x 1 Yr. x 30

Fringe = 9,500

C. Utilities Savings - Bldg. #34 = 4,000

D. Maint. Savings (Heat & Leak Repairs) 2,000

E. Lower O.H. Costs for Phase III (Total sq. footage for Phase III would be reduced by 45,640 sq. ft.) 10,000 - 20,000

F. Expense Reductions

1 Improved Ass'y Time

2 Faster Mat'l movements 10,000 - 20,000

3 Improved Lead Times

Total Estimated Savings/Yr. $39,865 -$59,865

EXHIBIT #10 (Sheet 3 of 3)

D. NEW PRODUCT REQUIREMENTS

1. 12" LIGHT UNIT

a. Analysis

Based on the customer survey conducted by the study team it has been confirmed that a 12" light unit is needed if we expect to secure a portion of the cantilever business. The recent trend by PUC orders has been to require that visual warnings be expanded to provide more lighted area at crossings, and the 12" light unit apparently meets this need.

b. Deductions

Based on the cost of our 8" HC-100 signal unit, it would appear that the selling price for a 12" light unit produced in our shop would be in the neighborhood of $60.00. (After TMC)

c. Recommendations

The development and design work on a 12" light unit should be started immediately if we expect to have this product on the market early in 1974.

2. CANTILEVER SIGNAL

a. Analysis

Based on the customer survey conducted by the study team, a development for a fixed aluminum cantilever with catwalk is needed immediately if we expect to capture our share of the highway crossing business.

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Kaiser Aluminum Co. supplied us with drawings of a cantilever which they designed and are now furnishing to Harmon.

Kaiser owns the drawings and will furnish us the detailed parts for our shop assembly.

b. Decuctions

Based on the cost estimate supplied by Manufacturing, it would appear that the cantilever unit can be produced competitively in our plant.

Manufacture	Description	Selling Price'
* WABCO	20' - 26' cantilever with catwalk	$1650.00
Western-Cullen	24' cantilever with catwalk	$1791.00

* Estimated selling price including 30% profit

c. Recommendations

A development program should be initiated as soon as possible so that product introduction can occur early in 1974.

3. Solid State Flasher Relay

a. Analysis

(1) Our competitors already have these devices on the market including Safetran, Edison, Western-Cullen and Harmon.

(2) Competitive Information

Supplier	Model	Description	Approx. Price
Safetran (Raco)	SSF-10	20 Amp (10 amp/ side)	$125.00
Edison	EOR	30 Amp (15 amp/ side)	130.00
Western-Cullen	EOR-720	40 Amp (20 amp/ side)	130.00
Harmon	1700C	40 Amp (20 amp/ side)	215.00
WABCO (for comparison)	(DV71407)	40 Amp (20 amp/ side)	Target 211.00
WABCO	FN-16A	20 Amp. Total	192.50

(3) We presently have an authorized development program for a Solid State Flasher (DV 71407). Design and laboratory tests are complete. Field tests are planned as soon as packaging is completed. These tests include checking the susceptability of the solid state circuitry to damage or malfunction due to electrical surges from nearby

electrical equipment or by lightning. The best guess for completion of this program is "after a summer storm season". Thus product introduction will be late 1974 at best.

can't we do this in lab?

b. Deductions

(1) Solid state flashers are an accepted product in the highway crossing market. Most customers are testing and will probably standardize on this device.

(2) Due to heavier load requirements a single flasher relay with a 15 amp. capacity is no longer sufficient. Using additional relays is not economical.

(3) Due to the heavier load requirements a device with a 40 amp. capacity (20 amp per side) is essential.

c. Recommendations

(1) We must accelerate the completion of the development program for our device. Tests must be completed and a product available by mid 1974 at the latest.

(2) Our targeted selling price of $210 - $220 must be held in order to be in a competitive position. This is most important due to our late entry into this product area.

4. Solid State Logic Unit (Crossing Control)

a. Analysis

(1) The railroads are moving very cautiously in this area. Although several customers are testing devices of this type, few, if any are in active service at this time.

(2) Electrical surges (lightning, etc) are a problem with this type of equipment.

(3) A good method of checking for proper operation is essential in a system. This is due mainly to the caliber of maintenance personnel available.

(4) Some preliminary research has been done and an abstract has been written by our R&D Department. No action has yet been taken on this abstract.

b. Deductions

(1) Most railroads are moving in this direction, and are willing to take a look at any reasonable system when it becomes available.

(2) The supplier who comes up with a good reliable system, priced right, and is easy to maintain will be in a very advantagous position.

(3) Due to low priority of the Feasibility Study (DV 73501) skilled manpower has not been available to work on this program. It is not possible to predict when this product will be available. How many years of testing?

c. Recommendations

(1) Accelerate the feasibility study for this product.

(2) Initiate a development program for this product aimed for prototype testing in 1974.

5. Grade Crossing Predictor

a. Analysis

(1) Safetran (Marquardt) has the only device of this nature on the market today. Four models are available, priced from $3175 to $4295, depending on the application requirements.

(2) There are rumors that Erico is coming out with their version, however, we have no confirmation at this time.

b. Deductions

(1) An analysis of the Marquardt schematics revealed that if we were to make a unit of this type we could not produce it competitively.

(2) All railroads surveyed have indicated that a considerable amount of maintenance is required to keep the units operating satisfactorily.

c. Recommendations

(1) It would not be in WABCO's best interests to enter into the development of a device of this type, at least at this time.

6. Gate Mechanism (New All-Purpose)

a. Analysis

A new mechanism is required to replace both the present lightweight and heavyweight models. This was brought forth by the So. Pacific, and others, in the form of critisisms and requested improvements to the present mechanisms as follows.

(1) Gate arm interferes with the light unit when in the vertical position.

(2) Mechanism is mounted to high on the pole for proper maintenance.

(3) The cams are not easily adjustable.

(4) Excessive shaft bearing wear. Suggest a double ended shaft and a new arm adapter.

(5) Mechanism must be capable of handling a 40 ft. aluminum gate arm.

b. Recommendations

It is suggested that the design of the new model also include the cost reductions recommended for the present mechanisms as outlined in Appendix IV of this report.

V. CONCLUSIONS

During the time of this study it was found that much of our inability to capture our share of the market was due to unsuccessful dedication of sufficient resources to implement previous plans. We have continually neglected our delivery problem which appears to be paramount amoung the short comings in our performance. Continuing in the highway crossing business as we have in the past, and without implementing the recommendations in this report will eventually force us to withdraw from the market.

Therefore, all possible efforts must be exercised to implement all recommendations contained in this report in order to put the Division in favorable position for increasing our dollar share of the market.

The potential market for highway crossing business is rapidly increasing and should continue fairly stable for the next 5 to 10 years, or longer.

We must make every effort to capture the Commercial Industry business. Since we now have this opportunity to sell highway crossing protection to commercial industries, the doors are also open for the sale of other product lines in the industrial area.

WABCO

It is important that we strive for full line capability in the shortest time possible to achieve full volume business. The most important phase of achieving our goal is to establish the Highway Crossing Center operations, which offer total control and fast response to the customer.

Consideration must also be given to reducing the overhead burden which is the outstanding cost factor of our product selling cost. In this regard, prompt serious consideration must be given to the implementation of the proposed manufacturing facilities relocation.

Exhibit #11 reflects the Proposed Action Plan and outlines the various function to be performed along with projected lapsed time for each function.

Exhibit #12 is a summary of the Projected Costs to implement the Action Plan.

ACTION PLAN

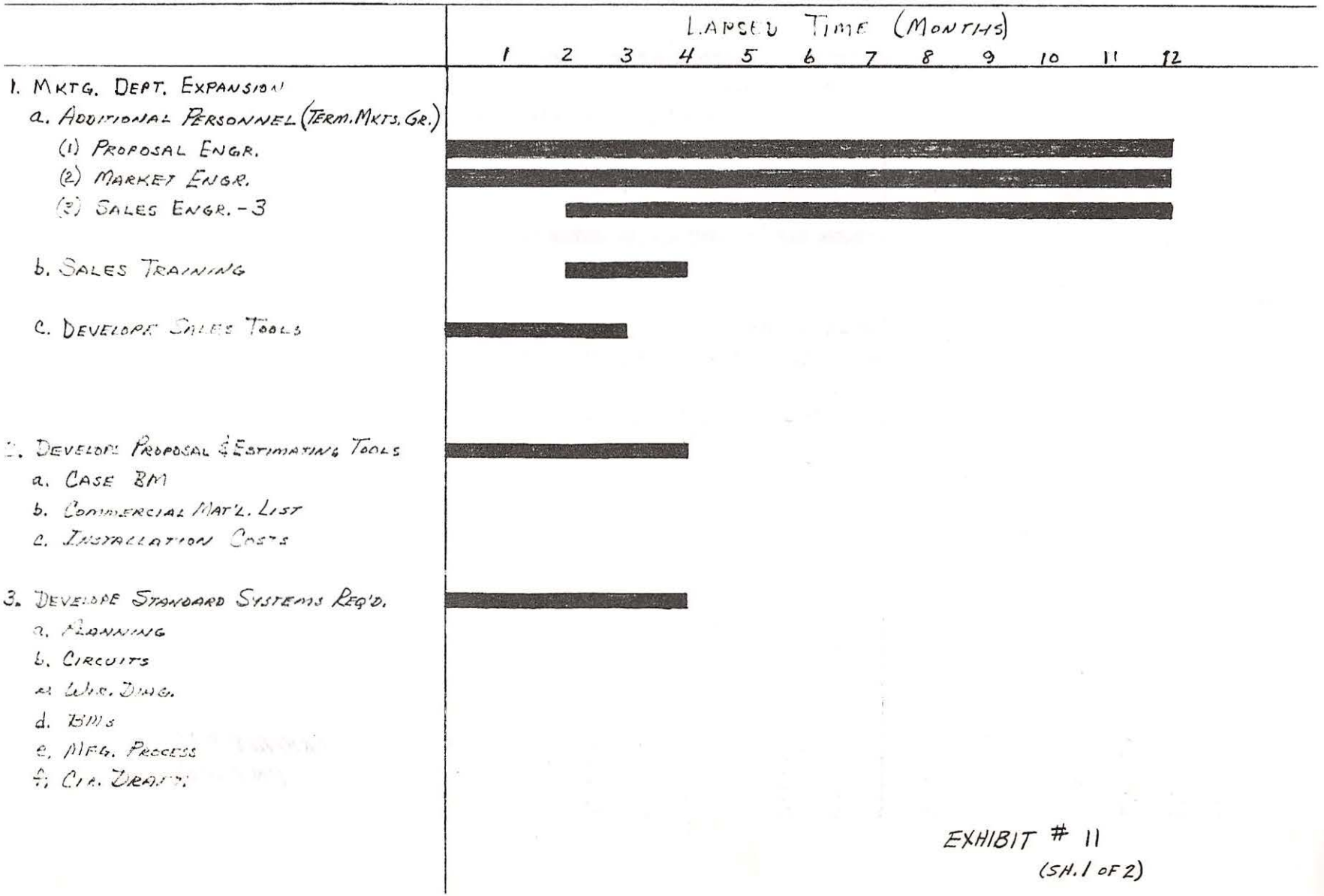

EXHIBIT # 11
(SH. 1 OF 2)

ACTION PLAN

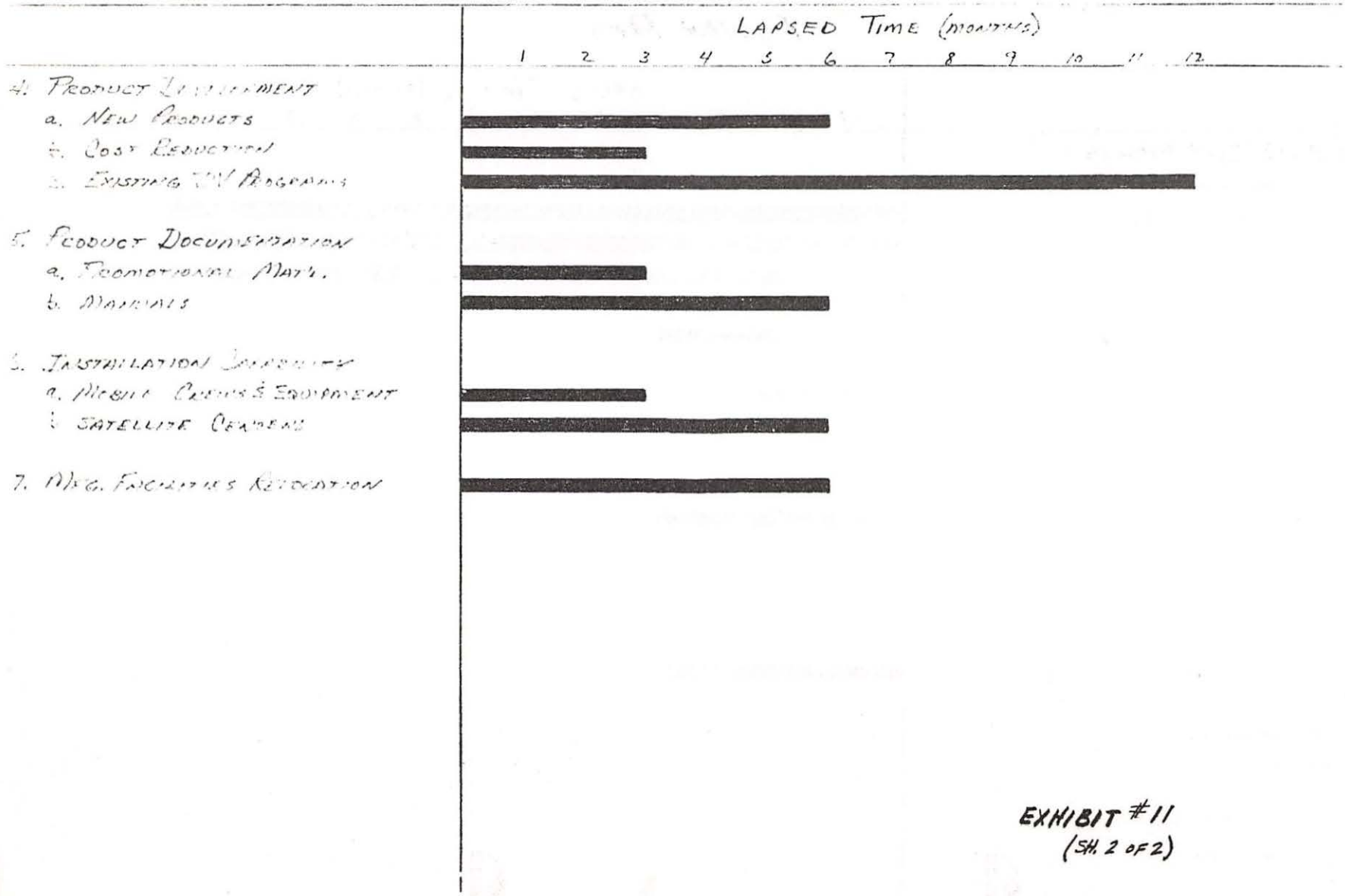

EXHIBIT #11
(SH. 2 OF 2)

WABCO

SUMMARY OF PROJECTED COSTS

A. Highway Crossing Center

1. Phase I (task Assignment per Exhibit #XI-1)

a. Permanent Staff Addns.	Annual Salary	Fringe Benefits	Expenses	Total
(1) Proposal Engr.	$12,000	3,600	-	$15,600
(2) Market Engr.	12,000	3,600	-	15,600
(3) Sales Engr-3	42,000	12,600	$30,000	84,600

b. Temporary Staff Addns.

(1) Installation Engr.	(4 months)	5,000
(2) Product Engr.	(4 months)	5,000
(3) Tech. Writer	(6 months)	6,000

Phase I Total $131,800

2. Phase II (task assignments per Exhibit #XI-2)

No additional cost

EXHIBIT #12 (Sheet 1 of 4)

SUMMARY OF PROJECTED COSTS (CONTINUED)

2. Phase III (task Assignment per Exhibit #XI-3)

a. Permanent Staff Addns.	Annual Salary	Fringe Benefits	Expenses	Total
(1) Market Technician	$11,000	$3,300	-	$14,300
(2) Sales Engrs. -2	28,000	8,400	$20,000	56,400

Phase III Total $70,700

B. Standardization

1. Engineering Support

a. Wiring Diagram	2,000
b. Engr. Drafting	3,500
c. Circuit Drafting	1,500
d. Rwy. Signal Section	2,500

Phase III Total $9,500

EXHIBIT #12 (Sheet 2 of 4)

SUMMARY OF PROJECTED COST (CONTINUED)

C. Cost Reduction

1. Existing Products

a.	AFO-I	None
b.	AFO-II	$3,000
c.	MM-10 (First Phase Only)	7,500
d.	AL-70 Gate Mech.	10,370
e.	Heavyweight Gate Mech.	3,000
f.	Gate Arms	1,200
g.	Signals	3,600
h.	Signs	775
i.	Wired Cases	1,200
j.	Relays	208
	Total	$30,853

D. Manufacturing Facilities Relocation

1.	Alternate #1 (Exhibit #9)	$521,800
	or	
2.	Alternate #2 (Exhibit #10)	406,800

SUMMARY OF PROJECTED COSTS (CONTINUED)

E. New Product Requirements

1. Existing Development Programs

a. Solid State Flasher (DV71407)

b. Solid State Logic Package (DV73501-feasibility study)

2. New Development Programs

a. 12-Inch Light Unit

b. Cantilever Signal

c. New Gate Mech.

d. High Current Rectifiers

e. Solid State Logic Package

(Costs to be determined after design specifications are finalized during Phase I of the Hwy. Crossing Center operation.)

EXHIBIT #12 (Sheet 4 of 4)

WABCO

APPENDIX I

I. AFO-I

A. Delivery

AFO I equipment has been classified as a "make item" available on a 120 day basis. Current plans call for future stocking for shipment on a 30 day basis.

B. Cost

A transmitter (high power) receiver pair has an inventory cost and selling price as shown below.

L	O	M	T	SP
$61.13	$90.85	$78.42	$230.40	$539.50

Harmon, perhaps our toughest competitor, would sell comparable equipment for $475.68 (1110BT & 1100BR, updated to June 1, 1973)

C. Acceptability

Our product has been used rather extensively by several customers. There is however, a current effort within the AAR to standardize characteristics of AFO equipment. When the standards are finalized, AFO I will require redesign to meet the new frequency standards. In addition the new standards might require all vital AFO applications to be modulated. If this, in fact, becomes a requirement AFO I

will automatically become obsolete.

D. Areas of Potential Improvement

A current DV program calls for replacement of the germanium transistors with more readily available silicon types. No other changes are programmed at this time.

E. Summary of Potential Changes

None

F. Product Documentation

Documentation should be updated to reflect pending change to silicon transistors.

G. Conclusions

No changes should be initiated pending definition of new standards for AFO applications by the AAR. The current DV, however, should be completed since the current germanium transistor types are becoming obsolete and eventually will be unavailable. This will permit continued sales of AFO I until the industry standards are classified.

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APPENDIX II

II. AFO-II

A. Delivery

AFO II equipment has been classified as "make items" available on a 150 day basis. Current plans call for future stocking for shipment on a 30 day basis.

B. Cost

A transmitter (high power) receiver pair has inventory cost and selling price as shown below.

L	OH	M	T	SP
$74.58	$92.85	$181.97	$349.40	$711.00

Considering Harmon OH's — this... product is cost competitive

Harmon, perhaps our toughest competitor, would sell comparable equipment for $692.00 (Model 1111 BT & 1111 BR, June 1, 1973)

C. Acceptability

Our product apparently is acceptable to most customers as far as its design and performance are concerned. However, there is a current effort through the AAR to create an industry wide standard for frequency allocation and spectrum utilization. It is too early to forecast what changes this program might require of ourselves and of our competitors.

In all probability, we will have to slightly modify our equipment to accomodate a new list of standard frequencies. Of course our competitors will also be in the same position since no supplier has adopted an entirely satisfactory family of frequencies.

D. Areas of Potential Improvement

1. Case

(a) Changes

A recent "Value Analysis" examination of the case design for the Motion Monitor (also applicable to A.F.O. II) has indicated some cost reduction potential. See attached Exhibit III-B (Appendix III)

Since it has not been verified that all of the changes planned will in fact be acceptable to the industry, the indicated cost reduction must be considered as a maximum.

The items most subject to question are:

1. Elimination of RSA terminals.
2. Elimination of protective back cover.
3. Elimination of protective front door.

(b) Improvement Expected

The cost reduction anticipated by the above analysis is about $13.37 per case or $26.75 per transmitter/receiver pair (DL&M)

(c) Cost of Change

The cost to redesign the case is between $1000 and $1500 (DL) and probably would require several months to complete.

(d) Payout

The cost of this change would be recovered through the sale of about 56 transmitter/receiver pairs.

2. Purchased Materials

(a) Changes

Several purchased components, mainly ferrite cores, are high cost items. There seems to be potential either to develop alternate sources and/or to purchase them in large quantities.

(b) Improvement Expected

Since a transmitter/receiver pair contains two cores worth about $20.00, a reduction of twenty percent will save $4.00 per AFO channel.

Other component costs could probably also be reduced similarly for a total cost savings of up to $8.00 per channel.

(c) Cost of Change

Locating alternate sources and arranging for quantity purchases could probably be accomplished for a cost of $1,000 to $1,500.

(d) Payout

The cost of making this change can probably be recovered through the sale of about 188 transmitter/receiver pairs. Of course, success is dependent upon our success in locating lower cost sources and/or willingness to stock larger inventories of components.

E. Summary of Potential Changes

Item	Est. Savings	Cost To Implement	Payout Units
Case	$26.75	$1000 - $1500	56 TX/RX Pairs
Pur. Mat'l	8.00	1000 - 1500	188 TX/RS Pairs
Total	$34.75	$2000 - $3000	87 TX/RX Pairs

F. Product Documentation

Existing & Presently planned documentation is satisfactory.

G. Conclusions

It is suggested that the first change, the case redesign, be made. The savings estimate appears to be reasonable and the payout acceptable.

APPENDIX III

III. MOTION MONITOR MM-10

A. Delivery

This is a new product which is currently available only on a limited basis.

B. Cost

A Motion Monitor unit has an inventory cost and a selling price as shown below.

L	O	M	T	SP
$56.70	$100.37	$233.94	$391.01	$780.00

The Marquart Motion Sensor unit is priced 86% above the MM-10. The price of other competitive units ranges to about 10% below the MM-10. See Exhibit III-A for comparison of features of various Motion Monitoring Systems.

C. Acceptability

Problems associated with motion monitoring applications are discussed in Engineering Statement ES004.

D. Plan for Product Finalization

Assuming a satisfactory resolution regarding handling of application problems a two phase plan should be established as follows.

1. Develop interim application rules for the existing MM-10. These rules should include items necessary for proper handling of application problems as described in Engineering Statement ES004.

2. Initiate a development program to update the MM-10 design in the areas indicated below.

a. Develop final application rules and documentation to permit general application of the Motion Monitor.

b. Explore the potential for developing a failsafe means of checking the integrity of the Motion Monitor track circuit using low impedance monitoring devices. If such a method is found economically practical, it should be included in the design specification.

c. Develop a revised design specification. This spec, should include features to comply with the final application rules, i.e., such items as an adjustable pickup timer for the motion sensing function. In addition, the unit should be repackaged to take advantage of at least some of the cost reduction outlined in a recent "Value Analysis" examination of the Motion Monitor case. (See attached Exhibit III-B and comments in Appendix II regarding a similar situation with the AFO II case.)

Also the frequency dependent elements should, in so far as practical, be grouped on one or two boards with the rest being common to all frequencies thus facilitating more acceptable spare parts handling.

EXHIBIT NO. III-A

Features of WABCO MODEL MM-10 MOTION MONITOR compared with similar devices marketed by competitors (Based on Advertised Data)

	MM-10 Motion Monitor	Safetran Motion Sensor	Harmon/1145A&46A Motion Detector II	Erico Movement Detector
Power				
Input Amp.	1.7A (input)	5.0 amp (input)	1.5 Amp (max.)	680 m.a.
Input Voltage	8.8 to 16.2VDC	8 to 14VDC	10.5-14VDC	10.5-14VDC
Wrap around req'd to provide broken rail protection	yes	optional	yes	optional
Modulation Check	yes--5 per sec.	yes--every 6 sec.	yes	yes--5 times per sec.
Rail connection	4 wires	5 wires	8 wires	4 wires
Positive Island CKT.	yes	yes	yes	yes
Island Relay	optional (external vital relay)	miniature built-in	yes	yes
Price	$780	$1456	$737	$795
Response Time	.1 to .5 sec.	2 - 5 sec.		
Detection Clearing	1 to 2 sec.	15 - 180 sec.	1 - 20 sec. Adj.	30 sec.

EXHIBIT NO. III-A
(continued)

	MM-10 Motion Monitor	Safetran Motion Sensor	Harmon/1145A&46A Motion Detector II	Erico Movement Det.
No. of Channels Available	6	10	23	21
Freq. Range	207-630 Hz	26.5-645 Hz	500-10200 Hz	313-2706 Hz
Detection Range (max)	2500 Ft.	5000 Ft.	2500 Ft.	3800 Ft.
Open Circuit Detection	No	Yes	No	Yes
Min. Speed Detected	4 MPH (worse case design limit)	2 MPH	2 MPH	2 MPH

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[illegible] MANUFACTURING COMPANY

INFORMATION WORKSHEET

VALUE ANALYSIS OF MOTION MONITOR CASE

By: E.C. DWYER & E.D. GARRETT

Product: Printed Circuit Board Box

Project: Cost Reduction

Quantity Required: 1000/year

APPLICATION AND MARKETING BACKGROUND:

The package proposed for housing printed circuit boards was done to avoid the higher cost universal module package.

The new package is basically a box approximately 6" high x 12" wide x 8-7/8" deep. It will be designed for rack mounting compatible with PN150 modular dimension with provision made for wall or shelf mounting. Terminals will be provided in front for field wiring.

Cost bogie for the package is:

L	O	M	Total
10	12	19	41

Unit sales for the MM10 will average 200/year, and for the AFO-11 800/year and for the Identra 100/year.

ENGINEERING BACKGROUND:

This box was originally designed in April, 1971. It was to replace a previous cast aluminum universal box that was too expensive. Also, there was a need to eliminate a separate mounting base. There are no patents issued. Size dimensions were restricted to be able to hold 5" x 7" printed circuit boards which was a basic reason for the box, to hold the depth to 9" maximum to fit in competitor's cases, and in multiple of 2-1/2" to nestle among plug-in relays when rack mounted. There were no restrictions on weight or type of material to be used. Operating environment will have a temperature range of -40 to +160 degrees F. Shock and vibration will be minimal. Expected life should be greater than 20 years. Rugged construction and a suitable chassis is more desirable than sexy appearance. Air flow is necessary for cooling components mounted on printed circuit boards.

MANUFACTURING AND PROCUREMENT BACKGROUND:

Sheet metal parts can be made in house. Assemblies and weldments can be performed in house.

Purchased components should be either standard catalog items or made from U.S.&S. owned tooling.

Part prints, assembly prints, operation records and cost information are available.

Parts or assemblies may also be purchased outside.

EXHIBIT III-B
(SH. 1 OF 3)

TEAM MEMBERS: Blazek, Dwyer, Garrett, Kramer, Lesko DATE: 3/8/73

FORM NO. [illegible] 12-68 VALUE ENGINEERING

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SUGGESTED DESIGN CHANGES - P.C. NO. 10X - [illegible]

Item #	Description	Action Recommended	Net Inv. Cost Savings 1	0	2	3
5	Chassis	Iridite instead of paint Change to aluminum	.4098	1.1506	-	1.5604
Sub 5	Top Cover	Eliminate 4 holes				
Sub 10	Bottom Cover	" 6 " and add material for shelf mount.				
Sub 20	Term. Bracket	Eliminates 2 holes				
Sub 25	Side Plate	" 2 "				
Sub 31	Tapped Bars (6)	Eliminate bars and assembly cost	.2100	.5694	.2286	1.0080
10	Back Cover	Eliminate	.0837	.2269	.0935	.4041
15	Door	Re-do for slide mount Iridite instead of paint Change to aluminum	.1477	.4268	-	.5745
20	Mtg. Bracket (2)	Eliminate	.1808	.4898	.0430	.7136
30	Term. Block	Eliminate AAR Term. Replace with Jones Term Strip (Price adjusted with allowance of .58 for new strip)	.0280	.0759	.3866	.4905
35	Term. Block					
55	Tag	Eliminate			.0250	.0250
[illegible]	Tag	"			.0250	.0250
65	Tag	"			.0250	.0250
70	Tag	"			.0250	.0250
75	Tag	"			.0250	.0250
80	Tag	"			.0250	.0250
85	Tag	"			.0250	.0250
90	Tag	"			.0250	.0250
95	Tag	"			.0250	.0250
100	Screws (10)	Eliminate and replace with pop rivets (Price adjusted with allowance of .112 for pop rivets)				
105	Washers (10)				.1230	.1230
110	Nuts (10)					
115	Connectors(5)	Change to new type 117 Buy in quant. of 100			4.9000	4.9000
[illegible]	Nuts (10)	Eliminate	.0200	.0460	.0800	.1460
125	Washers (30)	"			.1800	.1800
130	Nuts (20)	"	.0400	.0920	.3020	.4340

EXHIBIT III-B
(SH. 2 OF 3)

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Item #	Description	Action Recommended	Net Inv. Cost Savings L	O	H	T
5	Cloth Bag	Eliminate			.0324	.0324
150	Screws (2)	Eliminate			.0480	.0480
155	Screws (4)	"			.0308	.0308
160	Washers (6)	"			.0024	.0024
165	"O" Rings (2)	"			.0930	.0930
170	Tag	"			.0250	.0250
175	Name Plates (2)	Eliminate and replace with one name plate which includes term. ident. (Price adjusted with estimated allowance of 1.00 for new name plate			5.3092	5.3092
185	Screws (4)	Eliminate			.0320	.0320
190	Washers (4)	"			.0016	.0016
195	Nuts (4)	"			.0108	.0108
Miscellaneous - Reduction in assembly cost by implementing the above.			1.3191	1.7016	-	3.0207
	(A) Net Inventory Cost Savings		2.4391	4.7790	12.1719	19.3900

* * *

			Net Inv. Cost Increases L	O	H	T
5	Chassis	Change material to aluminum			1.0957	1.0957
15	Door				.1453	.1453
	(B) Net Inventory Cost Increases				1.2410	1.2410

* * *

Cost Summary	Inv. Level L	O	H	T
Original Cost	13.6211	22.0361	18.4816	54.1388
Less Adjusted Cost Saving (A-B)	2.4391	4.7790	10.9309	18.1490
New Cost (After Implementation) (% Cost Savings - 33.5%)	11.1820	17.2571	7.5507	35.9898

EXHIBIT III-B
(SH. 3 OF 3)

Team Members - Blacek, Dwyer, Garrett, Kramer, Lecko

Date - 4/25/73

APPENDIX IV

IV. GATE MECHANISMS

A. Delivery

Both the light and heavyweight mechanisms are currently "Make Items" available with a minimum 90 day lead time.

B. Cost

Based on latest available information, our gate mechanisms selling prices appear to be about 6% higher than competition.

C. Acceptability

LIGHTWEIGHT MECHANISMS--Some criticism has been directed towards the fact that the mechanism box is mounted too high on the mast, and that a ladder is needed in order to service it.

HEAVYWEIGHT MECHANISMS--Several customers have voiced the opinion that maintainence is difficult within the heavy-weight mechanism.

D. Areas of Potential Improvement

1. Lightweight Motor

a) Changes

Presently we manufacture this motor in our shop at a high cost.

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It is recommended that this motor be purchased from an outside source at a considerably lower cost. (The cost figures below were obtained through an estimate from Reliance Electric Co.) - Same features? what Quantity?

b. Improvement Expected

	L	OH	M	T (Inv.)
Present Cost	$57.10	$104.57	$43.33	$205.00
Proposed Cost	X	X	75.00	75.00
Savings	$57.10	$104.57	($31.67)	$130.00

c. Cost of Change

1-1/2 months Engineering support for design = $1800

1 month testing = 1200

Total estimated cost of change = $3000 (D.L.)

d. Payout

The cost of this change could be recovered by the sale of 23 units.

2. Heavyweight Motor

a) Changes

Like the lightweight motor, we manufacture this motor in our shop at a high cost.

It is recommended that this motor be purchased also from an outside source.

b. Improvement Expected

	L	OH	M	T (Inv.)
Present Cost	$51.62	$96.32	$48.03	$195.97
Proposed Cost	X	X	80.00	80.00
Savings	$51.62	$96.32	($31.97)	$115.97

c. Cost of Change

1-1/2 months Engineering support for design	=	$1800
1 month testing	=	1200
Total estimated cost of change	=	$3,000 (DL)

d. Payout

The cost of this change could be recovered by the sale of 26 units.

3. Gears (Lt. Weight Mechanism)

a. Changes

Install a small heating furnace in section 385 as the gears (pc. nos. 451071-1801 & 451071-1802) are made from 1035 steel and as a result have to be both "Pre" and "Post" heated in order to attain a desirable weld.

This method is now performed by hand and is very time consuming. By installing a furnace we could reduce the operation time considerably.

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b. Improvement Expected

Reduce the time to perform the operation from 10 minutes or $1.81 (L & O.H.) to 2-1/2 minutes or o.45 (L.& O.H.)

c. Cost of Change (Estimated)

Furnace should be a small firebrick, gas fed structure.

$100	(Material Costs)
$150	(One week expense labor)
$250	Total Est. Cost to Implement

d. Payout

The cost of this change could be recovered by the sale of 92 units.

4. Segment Gear (451071-1601)--Lightweight Mechanism *

a) Changes

Change the production method from flame cut to forge which results in material and direct labor reductions.

b) Improvement Expected

	L	OH	M	T (Inv.)
Present Cost =	$2.729	$6.987	$3.053	$12.769
Proposed Cost =	2.309	5.774	1.412	9.495
Savings =	$ .420	$1.213	$1.641	$3.274

*This recommendation was put into effect during July, 1973.

c. Cost of Change

New Tooling $500.

d. Payout

The cost of this change would be recovered by the sale of 76 units.

5. Clutch (J-705032)--Lightweight Mechanism **

a) Changes

Presently we purchase this part in small quantities.

A significant cost reduction could be realized if we purchased this item in larger quantities.

b) Improvement Expected

	L	OH	M	T (Inv.)
Present Cost =	X	X	$33.10	$33.10
Proposed Cost =	X	X	12.70	12.70
Savings =	X	X	$20.40	$20.40

c) Cost of Change

Purchase item in 1000 lots = $33,100.00

$33,100 in inventory @ 20% = $ 6,620.00/year

d) Payout

The cost of this change could be recovered by the sale of 325 units.

** This item is currently under study by Engineering.

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E. Summary of Potential Changes

1. Lightweight Mechanism

ITEM	Est. Savings	Cost To Implement	Payout Units
Motor	$130.00	$3,000	24
Gear	2.72	250	92
Segment Gear	3.27	500	76
Clutch	20.40	6620	325
Total	$156.39	$10,370	67

2. Heavyweight Mechanism

Item	Est. Savings	Cost To Implement	Payout Units
Motor	$115.97	$3,000	26

F. Conclusions

One of the reasons that long lead times occur, is the fact that orders are released to the shop at a point in time when material levels are low. To be more specific, we allow our stocking levels to drop too low before we reorder or replenish.

The most consistant part that creates a material shortage or delay, is the motor that is used on these mechanisms.

One of the reasons for this is the fact that the motor has so many manufactured parts to it, and a great deal of time is needed for these orders to hit the floor and the details machined, etc. As a result, the other mechanism parts arrive at Department 340 before the motor parts, thus creating a bottleneck.

There are two recommendations for the problem:

1. Purchase the motor (this is probably the most advantageous of the suggestions as the cost to make the motor in our shop, is extremely high).

2. Go to a heavier stocking program which would certainly increase the inventory.

Another problem area in Dept. 340 is the simple fact that there are too many parts in stock or storage, over 50% of the work area is presently being used as a storeroom, in general we assemble too many products in too small an area.

Since the lightweight crossing gate represents approximately 25% of Department 340's work and overall highway crossing approximately 40 to 50%, it is recommended to segregate the highway crossing equipment and its associated parts from the other products within Department 340 such as subway signals, switch machines, etc.

By purchasing the motors, we will realize additional floor space that previously had been utilized by the the assemblies and related sub-assemblies of the motors.

Also assembly type bench areas should be laid out that would include the stocking of miscellaneous hardware such as nuts, bolts, etc., at the bench areas. A great deal of time is presently spent on moving the mechanisms from one work area to another and the material flow within the department including the sub-assemblies is very poor.

An overall study of the highway crossing piece numbers would have to be made to determine:

a) Amount of space required to store or stock the materials (both raw and sub-assemblies at a given level).

b) The sequence of work operations to determine proper layout of work areas, to include tooling, benches and material moving or handling equipment.

These recommendation in all probability would not drastically reduce the direct labor cost of the products, but in relationship, we would be minimizing down-time by better controlling work methods and manpower utilization, which has an end result on the overhead costs and lead times.

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APPENDIX V

V. GATE ARMS

A. Delivery

Our aluminum crossing gate arms are currently "Make Items" available with a minimum 60 day lead time.

B. Cost

Based on latest available information, the selling price of our gate arm appears to be in line with competition.

C. Acceptability

The aluminum gate arm has been accepted very favorably in the industry, as far as design and performance are concerned.

D. Areas of Potential Improvement

1. Changes

a. Materials

The present reflective tape that is applied to the gate arms, consists of a white base with a red tape lapped over the white at sixteen inch intervals.

A material savings could be realized by converting to individual sixteen inch tape strips.

This change will be implemented as soon as the present stock is depleted.

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b. Fabrication

Presently our method for drilling holes through the aluminum extrusions includes burring all the holes both inside and outside. The majority of this burring could be eliminated by converting to a finer toothed fly cutter when cutting the 1-1/4" light holes, and using a thicker lipped grommet for the light assembly.

Another fabrication method that could be improved upon is the welding and grinding of the arm blocks. The present design calls for the six blocks to be welded to the arm at all four sides of the block, however if this method was changed to weld at just two sides, the welding time could be reduced considerably and the grinding operation of the block tops eliminated.

Product improvement as well as a significant cost reduction could also be realized by painting the gate arms white before application of the reflective tape.

The bare aluminum arms are presently cleaned with perchlorethylene to remove dirt and grease prior to the tape application and afterwards the tape edges are coated with a sealer to prevent peeling. The painting method should eliminate these two operations and is also less costly.

c. Improvement Expected

PRESENT COST-(INV)	L	OH	M	T
Mat'l (Tape & Extrusions)	X	X	$44.05	$44.05
Weld	1.66	2.97	X	4.63
Grind	.39	.82	X	1.21
Drill & Burr	3.54	7.42	X	10.96
Clean	.67	1.72	X	2.39
Apply Tape	6.27	16.11	X	22.38
Total	$12.53	$29.04	$44.05	$85.62

PROPOSED COST-(INV)	L	OH	M	T
Mat'l (Tape & Extrusions)	X	X	$30.63	$30.63
Drl & Weld	$ 4.72	$ 9.43	X	14.15
Paint	X	X	4.50	4.50
Apply Tape	X	X	15.00	15.00
Total	$ 4.72	$ 9.43	$50.13	$64.28

	L	OH	M	T
Savings/Gate Arm (INV)	$ 7.81	$19.61	($6.08)	$21.34

d. Cost of Change

New tooling and routine changes to drawings $1200.

e. Payout

The cost of this change would be recovered by the sale of 56 gate arms.

E. Summary of Potential Changes

1. Gate Arms

Est. Savings	Cost to Implement	Payout Units
$21.34	$1200	56

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F. Documentation

If we supply our gate arms painted, we should reflect this improvement in our product bulletins and sales literature.

G. Conclusions

The labor costs for fabricating the gate arms in our shop, have escalated tremendously, particularly the tape application.

Originally, these work operations were time-studied, and the piece work rates established at that time were on an average, 40 percent less. However due to union grievances and negotiation settlements, the labor rates have been allowed to increase to the point where the only plausible solution in reducing labor costs, is to remethodize our work operations in order to establish new piece work rates. The painting and new tooling recommendations should have a favorable impact on sales volumne, as product improvement will be realized in the following areas:

1. Appearance
2. Reflectability
3. Lower Costs

APPENDIX VI

VI. Signals

A. Delivery

The HC-100 signal assemblies are currently "Make items" available with a minimum 60 day lead time.

B. Cost

In order to maintain a competitive position, the HC-100 signal unit is sold below total product cost (-8%).

Still our product is priced higher than competition as reflected in the tabulation below:

PRODUCT	WABCO	WESTERN-CULLEN	HARMON
2 Unit Light	54.00	45.00	39.00
4 Unit Light	79.50	57.20	71.00

C. Acceptability

The HC-100 Junction Box cross arm is not acceptable to several customers because interchangeability is not possible with other suppliers light units..

Also our customers have been directing criticism towards the cross arm as more space is needed between the light units to allow the gate arm to swing between them in a vertical position.

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D. Areas of Potential Improvement

1. U-Bolt (M-329791-001) HC-100 ALUM*

a. Changes

In order to manufacture this part, our present method is to cutoff, thread and hot bend.

This method should be changed to shear, point thread and cold bend, which can be accomplished in less time.

b. Improvement Expected

	L	OH	M	T (INV)
PRESENT METHOD	$ .376	$1.609	$.500	$2.485
PROPOSED METHOD	.094	.367	.489	.950
TOTAL	$ .282	$1.242	$.011	$1.535

c. Cost of Change

NONE

d. Payout

A $1.535 (INV) savings would be realized on each unit sold.

* The above recommendations was implemented and put into effect by the study team during June, 1973.

2. Aluminum Pole *

a. Changes

Presently we purchase our poles from a high cost vendor.

A new source has been located. They will supply the poles at a lower cost.

For How long?

b. Improvement Expected

	L	OH	M	T
Present Cost =	X	X	$32.54	$32.54
Proposed Cost =	X	X	27.72	27.72
Savings =	X	X	$ 2.82	$ 4.82

c. Cost of Change

NONE

d. Payout

A $4.82 savings will be realized on each unit sold.

* The above cost reduction was implemented and put into effect by the study team during August, 1973.

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E. Summary of Potential Changes

Item	Est. Savings	Cost to Implement	Payout Units
U-Bolt	$1.535	NONE	1
Aluminum Pole	4.82	NONE	1
Total	$6.355	NONE	1

F. Product Documentation

Present documentation must be updated to include recommended changes.

G. Conclusions

After an in depth investigation of the HC-100 light unit, it appears that cost reductions have reached the point of no return as presently designed. The manufacturing methods are well founded and the majority of the work operations have been time studied. The piece work rates are justified.

Still the HC-100 unit is higher priced then competition and not acceptable to several customers. (Sales have declined over 50% during the last two years.)

A redesign is needed on both the HC-100 crossarm and light unit if we expect to capture our share of the market. These redesigns should include:

1. Redesign the adjustable positioning mechanism to eliminate the ball and socket on the crossarm and signal unit. Any new arrangement must be compatible with industry

standard design.

2. Allow more space between the light units for the gate arm when in the vertical position.
3. In addition, the cost-reduced crossarm redesign should consider the elimination of aluminum castings. Projected cost of re-designed crossarm--$3600 (DL). ? Competition
4. The redesign should include the option of furnishing the light units with Lexan lenses.

APPENDIX VII

VII. SIGNS

A. Delivery

Presently all of our signs are "Stock items" 30 day lead time.

B. Cost

We sell our signs at total product cost level with little or no profit margin included. Even with this concession our selling price is significantly higher than competition, as reflected in the tabulation below:

Product	WABCO	Western-Cullen	Safetran
R. R. Crossing	$43.50	$37.00	$30.00 (EST).
Track	32.00	23.00	19.00
Stop-On-Red	36.50	30.00	21.00

C. Acceptability

All of our signs are acceptable to customers as far as design and performance are concerned.

D. Areas of Potential Improvement

1*. Packing for Shipment

a. Changes

* The above recommendation was implemented and put into effect by the study team during July, 1973.

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Present method calls for the fitting used to mount the crossing grade signs to be individually packaged in Dept. 340 at a cost of .41 ea. (INV. LAB.).

The fitting should be sent to the shipping department where it can be packed in the same container as the crossing sign, at no additional cost.

b. Improvement Expected

The present cost of packing the fitting at inventory level is:

L	OH	M	T
.405	.960	x	1.365

c. Cost of Change

NONE

d. Payout

$\frac{\$1.365 \text{ (PRESENT COST)}}{\text{Cost to implement (none)}} = \$1.365 \text{ savings/unit}$

2. R.R. Crossing Sign

a. Changes

Presently our signs are purchased with a reflective coating.

Costs could be reduced by changing to a lower cost scothlite #3270 grade reflecting tape.

b. Improvement Expected

PRESENT COST

	L	OH	M	T
Purchased Signs	X	X	$32.62	$32.62
Total	X	X	$32.62	$32.62

Proposed Cost	L	OH	M	T
Purchase Extrusions	X	X	$ 5.94	$ 5.94
Purchase Reflective Tape	X	X	8.76	8.76
Drill(2) HLS & Apply Reflective Tape Sheets In Our Shop	.40	.90	X	1.30
Total	$ .40	$.90	$14.70	$16.00
Savings/Set	($.40)	($.90)	$17.92	$16.62

c. Cost of Change

Tooling cost for new die $525.00

d. Payout

The cost of this change could be recovered by the sale of 33 units.

3. "Stop on Red Signal" Sign

a. Changes

Presently we send a blank panel out to a vendor who applies a reflective coating for $10.44 each.

A cost reduction could be realized by purchasing finished reflective scothlite tape strips from IDL Inc., and applying the tape to the panels in our shop.

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b. Improvement Expected

Present cost of "Stop-On-Red" Sign.

	L	OH	M	T
Reflect. coating	x	x	$10.44	$10.44
Metal Panel	$.19	$.35	$ 2.92	$ 3.46
Total	$.19	$.35	$13.36	$13.90

Proposed Cost

	L	OH	M	T
Metal Panel	$.19	$.35	$2.92	$ 3.46
Scothlite Tape	x	x	7.91	7.91
Lab. to Apply Tape	.10	.20	x	.30
Total	$.29	$.55	$10.83	$11.67
Savings	($.10)	($.20)	$ 2.53	$ 2.23

c. Cost of Change

Changes to drawings and routine records would cost about $250 (D.L.)

d. Payout

The cost of this change would be recovered by the sale of 113 units.

E. Summary of Potential Changes

1. "RAILROAD CROSSING SIGN"

ITEM	EST.SAVINGS	COST TO IMPLEMENT	PAYOUT UNITS
Fitting	$ .41	NONE	1
Sign	16.62	525	33
Total	$17.03	525	31

2. "STOP ON RED" SIGN

ITEM	EST. SAVINGS	COST TO IMPLEMENT	PAYOUT UNITS
Fitting	$ .41	NONE	1
Sign	2.33	250	113
Total	$ 2.74	250	91

3. "TRACK" SIGN

ITEM	EST. SAVINGS	COST TO IMPLEMENT	PAYOUT UNITS
Fitting	$ .41	NONE	1

F. Documentation

Present documentation is adequate.

G. Conclusions

The recommended schothlite tape is the same type of reflective material that is presently used on our gate arms and which has been favorably received by the railroads.

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By converting to the tape method, our crossing signs will be in a better competitive position.

Further cost reduction might be realized by investigating the possibility of changing material from aluminum to a durable plastic, fiberglass or other suitable type, as the present material costs seem high.

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APPENDIX VIII

VIII. WIRED CASES

A. Delivery

Signal cases are currently a "Make Item" available with a minimum 90 day lead time.

B. Cost

Based on limited available information, the manufactured costs of our wired signal cases appear to place our selling cost above commercial competion.

At present, most of the railroads through contractual commitments are using the "Brotherhood of Railroad Signalmen", for wiring effort in their own shops. A cost comparison of these wiring costs is not available at this time.

C. Acceptability

Our product is acceptable to customers as far as its design and performance are concerned.

D. Areas of Potential Improvement

1- Wire

a) Changes

Replace presently used "Kerite" type wire with lower costing PVC or other types.

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b. Improvement Expected

Present cost of "Kerite" wire is $40/case. Lower costing wire is $20/case (estimated).

c. Cost of Change

None

d. Payout

Since no costs are required to make this change savings would be realized from the first case onward.

2. Terminal Strips

a. Changes

Replace presently used terminal strips with "Barrier" type terminal strips if it can be determined that this type of terminal will be acceptable to our customers.

b. Improvement Expected

Present cost of terminal strips are $1 per terminal, "Barrier" type are .50 per terminal with about 24 terminals required per case.

c. Cost of Change

$600 (2 wks. Engrg)

d) Payout

The cost of this change would be recovered by the sale of 50 wired cases.

3. Cable Protection

a) Changes

Presently we purchase steel tubing, cut it to length, drill & tap (3) set screw holes and paint it in our shop at a high cost. Remove steel tubing from bill of material and supply only as an optional extra.

b) Improvement Expected

	L	OH	M	T
Present Cost of Protector	1.22	3.14	7.66	12.02
Proposed Cost (Eliminate Item)	x	x	x	x
Savings	$1.22	$3.14	$7.66	$12.02

c) Cost of Change

Drawings and Records $600.

d) Payout

The cost of this change could be recovered by the sale of 50 units.

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E. Summary of Potential Changes

Item	Est. Savings	Cost To Implement	Payout Units
Wire	$20/Case	NONE	1
Term. Strip	$12/Case	$600	50
Cable Protector	$12/Case	600	50
Total	44/Case	$1200	28

F. Product Documentation

System application and service manuals will be required when wired cases are supplied as a part of a complete Highway Crossing Protection package.

G. Conclusions

Standardize on a lower cost wire that would meet the needs of the commerical industrial customers. However, the Kerite wire would still be supplied upon request but at a premium.

The acceptability of the "Barrier Strips" by the railroads is questionable, some investigating would have to be undertaken to assure that this change is acceptable.

The majority of the components used in the wired cases have already been cost reduced. The manufacturing methods and rates appear to be in line and justified.

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The only area where a significant cost reduction could be realized is standardizing on case design which would result in volume type wiring and assembly. However, because of so many different types of signaling systems, further study is required before such a cost reduction could be verified.

(1) Time / material delays adding to costs in IND ?
(2) Comparison with RR wiring cost
(get CES memo on this subject)

APPENDIX IX

IX. RECTIFIERS

A. Introduction

Four basic types of rectifiers are available for various types of applications. Two of these, constant current (CCR) and constant potential (CPR) have been recently redesigned and cost reduced. There seems to be little or no problem with with their acceptability.

The other two types, known as CCRA and CPRA, are new designs with automatic regulation and were developed specifically for battery charging applications. The CPRA, is a constant potential, taper charge design with float charge, current limiting and equalizing charge features. Its performance characteristics are similar to those available on the commercial market and is intended to compete with the higher quality units supplied by LaMarche and others.

B. GENERAL INFORMATION

The CCRA is a novel design automatic two rate charger which continuously cycles the battery between two precisely established voltages such that the battery is maintained at a fully charged state but without risk of over charging. The high-low rate time cycle, automatically adjusts to varying load conditions.

This type of unit should find wide use in applications where large ratios of minimum to maximum load current and irregular "load cycles"occur.

Industry has for many years struggled with various methods of charging storage batteries. The most recent and now widely accepted method is the constant potential taper charge as provided by the CPRA units described above. However, even this method falls short of desired results due to variations in cell characteristics. Not all cells within the battery receive the same "effective" charge. Hence, the equalizing charge feature is required. Based on battery charging theory,and upon the rather limited test data available, the CCRA method does not suffer from this same problem because in effect, it provides the equivalent of an equalizing charge on each high rate pulse. Since the high rate pulse is of short duration, perhaps only a few seconds, gassing with resultant water loss is very much less than with other charging methods.

While the CCRA features are unique in battery chargers and offers potential superior performance there may be limitations to its applicability to systems, such as those containing electronic devices which may be sensitive to the cycle variation in battery voltage inherent to operation of the automatic two rate charging method.

There has been a trend recently toward higher current ratings for rectifiers used with some highway crossing installations. Current requirements as high as 40 amperes have been stated by some customers. It appears quite feasible to apply the principles of at least three basic types of rectifiers to larger units.

While the CCRA design is feasible, it is questionable whether the power lines feeding some locations could tolerate the high cycle current surges inherent to this type device. Some analysis of this latter problem is indicated before designing high current CCRA devices.

C. PRICE

Price comparisons for the CPR and CCR units show a satisfactory competitive position. Since the CPRA and CCRA units are new and have not yet been released for production, accurate data is not yet available. However, based upon projected manufacturing cost data selling prices for these units may be somewhat above competition.

D. CONCLUSIONS

The new rectifier product line appears to meet most needs of highway crossing protection systems. However, several points need to be explored and clarified.

These are listed below:

1. Investigate effects of cycle variation of battery voltage as caused by automatic two rate charging.

2. Rectifiers with higher output currents should be designed to meet recent demands.

APPENDIX X

X. RELAYS

A. Delivery

The majority of the relays used in Highway Crossing Systems are "Stock Items" available with a minimum 30 day lead time.

B. Cost

Based on latest available information, the selling prices of both shelf and plug-in type relays appear to be competitive.

C. Acceptability

All of our relays are acceptable to our customers as far as design and performance are concerned.

D. Areas of Potential Improvement

*1. Name Plates

a) Changes

Presently all the relay name plates are stamped using a machine with a manual dial selector.

A new typewriter stamping machine is presently on order which should reduce the stamping operations by 50%.

WABCO

b. Improvement Expected

	L	OH	M	T (Inv)
Present Cost (Avg. N. Plate)	$.10	$.25	$1.00	$1.35
Proposed Cost	.05	.12	1.00	1.17
Savings	$.05	$.13	x	$ .18

c. Cost of Change

New Machine = $2500, ammortized @ 8.3% = $208/yr.

d. Payout

The cost of this change would be recovered by the sale of 1156 units.

E. Summary of Potential Changes

1. Relays

Item	Est. Savings	Cost To Implement	Payout Units
Name Plates	$.18	$208	$1156

* The above cost reduction was implemented by the manufacturing department and should not be construed as a study team cost reduction recommendation.

F. Product Documentation

No Change

G. Conslusion

The majority of all our relays have been, or are in the state of being cost reduced.

The overall production methods and procedures are well founded.

However, some recommendations should be implemented that would reduce down time and decrease long lead times as follows:

1. Presently one drill press is available in Dept. 240 for drilling the contact blocks for both the PN-150 & PN-250 relays. As a result only one series can be worked on at a time.

The same situation exists for aligning the contacts, one fixture is presently used for both relays.

Production time improvement, as well as any expected increase in relay volumne justifies additional tooling so that both relay types can be worked on simultaneously.

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2. Another problem which is causing production delays in the relay area, is the long delay encountered whenever production tooling replacements or repairs are ordered from our toolroom.

A check of the toolroom has revealed that at present this department has a large backlog. This backlog in all probability will not be reduced in size. As of this writing, only 5 of the 9 total employees on the Toolroom Department roll are working.

It is recommended that immediate action be taken to correct this deficiency as this problem not only has an impact on the relay business, but all of the Division's product lines.

As of (8-1-73, the study team brought these findings to the attention of the Manufacturing Department.

3. Purchased raw materials must also share the responsibility for long turn around times, primarily silicon steel. At present, six to nine months delivery time is required when ordering silicon steel from vendors.

If this problem does not improve, we must adjust our raw material inventories to coincide with projected business forecasts to compensate for this delay.

4. Another problem area which is contributing to production delays is the #1 Burgmaster machining center. Currently a large number of detailed relay parts, as well as numerous other parts for other product lines, pass through this work station. It appears that capacity capabilities are questionable.

Of the two small burgmaster drilling machines, manufacturing is presently utilizing one machine for two turns and the other machine, one turn.

Improvement should be made in this area. A spot check of detail parts has revealed that some parts are delayed at this work station for long periods of time due to the backlog of parts waiting to be machined.

It is recommended that a capacity study be made of this machining center, and if warranted, increase the capabilities at this work station by adding another work shift.

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APPENDIX XI

XI. HIGHWAY CROSSING CENTER

A. Development

Our success in this business area depends, to a very large extent, on our ability to respond to bid proposals and delivery requirements. We must be in a position to provide bid proposals upon request with a maximum time of 5 days, depending on the nature and complexity of a proposed system. We must have the capability to process and ship S.P. & E. orders, and standard system orders, within 30 days. Non-standard system orders will be processed for shipment on an extended time basis beyond 30 days, depending on the complexity of the system.

B. Organization

The primary responsibility of the Highway Crossing Center is to promote and actuate sales proposals, S.P. & E. and system purchase order handling procedures and coordinate installation facilities in the highway crossing business area. new

The Highway Crossing Center will include the Product Manager, Proposal Engineer, Market Engineer and Industrial Sales Engineers. The Highway Crossing Center would be under the jurisdiction of the Terminal Markets Group with responsibility for preparation of bid proposals, processing system orders, provide sales coverage, manage satellite

new new new – OK ?

WABCO

installation centers and follow up with new product development.

C. Functions

1. Highway Crossing S.P. & E. Orders

Incoming S.P. & E. orders for highway crossing protection will be processed by Customer Service. Terminal Markets department will monitor S.P. & E. stock inventory. The Product Manager will be responsible for forecasting S.P. & E. for stock inventory.

2. Sales Proposals

All sales proposals for equipment and installation will be prepared within the Highway Crossing Center.

This function must be performed in the Terminal Markets area, in order that communications with the customer will be more consistant, and immediate decisions can be made.

3. System Orders

a. Standard System (30 day delivery, or less)

A standard system is a pre-engineered arrangement that only require verification of materials in stock and scheduling for immediate shop handling.

Circuits schematics, wiring diagrams and bills of material for pre-engineered standard systems will be on file.

All orders for standard systems will be processed for shipment by Customer Service and Terminal Markets Group.

The Terminal Markets Group will be responsible for design, material stock verification and shop scheduling. Standard systems will not be routed through System Engineering due to the nature of a pre-engineered system.

b. Non-Standard Systems

A Non-Standard System requires additional System Engineering time for circuit and wiring diagram generation. When a sales proposal is prepared for a non-standard system, the engineering will be a joint effort between Systems Engineering and Terminal Markets Group to determine actual engineering design costs and lead time required to manufacture the system when the order is received.

When the order is received, it is routed through all phases of the order handling process which includes engineering design, material ordering, UE bills of material preparation, manufacturing and shipment.

It is anticipated that with judicious handling and scheduling, it will be possible to ship a non-standard system in approximately 30 - 45 days, depending on the complexity of design and other factors.

WABCO

4. Proposed Phase Operations

The following outline will recommend phase procedures to be implemented for developing the Highway Crossing Center operations. Each phase is catagorized by Existing, New and Supporting personnel requirements. The nature of each function with regard to scope and responsibility is indicated on Exhibits #XI-1, XI-2 & XI-3.

A. Phase I

Phase I proposes adding the required new personnel to the Terminal Markets Group. Certain personnel are supporting in nature and will be temporary for a period of time until tasks are completed. Necessary aids required to perform new functions will also be developed.

The time required to complete Phase I should be approximately 120 days providing that all efforts are co-ordinated and properly executed. Exhibit XI-1 reflects the staffing requirements for Phase I.

PHASE I. HIGHWAY CROSSING CENTER

FUNCTION: STAFFING & DEVELOPMENT OF FACILITY

TERMINAL MARKETS GROUP

PERSONNEL REQUIREMENTS	SCOPE OF RESPONSIBILITY
Existing (Permanent)	
1 - Product Manager -	Responsible for Highway Crossing Center Development and Operations.
New (Permanent)	
1 - Proposal Engr. -	Develop proposal documents, estimating tools and assist with developing sales contacts. + Estimate job
Engr 1 - Market Engr. -	Develop standard systems and inventory list. + order on shop
3 - Sales Engr's -	Establish contacts with industrial customers. for 600K commercial business! How about the 4900K RR business? / Territory Customer visibility jurisdiction, etc.
Supporting (Temporary)	
1--Installation Engr.	Develop installation capability (- or develop consortiums/agreements etc?)
Engr 1 - Product Engr.	Initiate new products, cost reduction programs, and evaluate and update existing product development programs.
Mkt Tech 1 - Tech. Writer	Develop advertising aids, promotional material, product bulletins and service manuals.

EXHIBIT #XI-1

WABCO

B. Phase II

At the beginning of Phase II most functions and the scope of operations should be well established. All tasks should be performed on a routine basis directed towards building up volume business. At this time all bid proposals and purchase orders for highway crossing protection will be routed through the new operation. Building up volume business during Phase II will depend largely on our ability to establish commercial industrial accounts and meeting their requirements for equipment and deliveries.

Phase II will continue in operation until such time as the business volume warrants the expansion of the operation.

Staff requirements for Phase II are shown in Exhibit #XI-2.

PHASE II HIGHWAY CROSSING CENTER

FUNCTION: BUILDING VOLUME BUSINESS

TERMINAL MARKETS GROUP

PERSONNEL REQUIREMENTS	SCOPE OF RESPONSIBILITY
Existing Staff (from Phase I)	
1 - Product Manager	Responsible for Highway Crossing Center operations
1 - Proposal Engr.	Prepares estimates and proposals, supports sales engineers regarding problems, assist market engr.
1 - Market Engr.	Handles system orders including coordination with systems Engr. Dept. on non-standard system orders monitors inventory, co-ordinates field installation.
3 - Sales Engineers	Expand Highway Crossing Sales coverage.

this may be too large a job particularly if we sub-contract or form consortium

NOTE: Systems Engr. Dept. will continue to handle non-standard complex systems and provide consulting services.

EXHIBIT #XI-2

WABCO

C. Phase III

This operation is aimed at further expanding the Highway Crossing sales coverage in the commercial industrial and Class 2 railroad areas.

Field sales offices would be established in strategic locations to handle increasing business. Highway Crossing Center facilities would be expanded accordingly as shown in Exhibit #XI-3.

Should we not do this in Phase I to get the RR business volume ?

PHASE III

FUNCTION: EXPANSION OF SALES COVERAGE

TERMINAL MARKETS GROUP

PERSONNEL REQUIREMENTS	SCOPE OF RESPONSIBILITY
Existing Staff (From Phase II)	
1 - Product Manager	Same as Phase II
1 - Proposal Engr.	Same as Phase II
1 - Market Engr.	Same as Phase II
3 - Sales Engr's.	Same as Phase II
New Requirements	
1 - Market Technician	Assist Market Engr. & Proposal Engr. more liaison etc.
2 - Sales District Offices	Expansion of Sales coverage

NOTE: Systems Engr. Dept. will continue to handle non-standard complex systems and provide consulting services.

EXHIBIT #XI-3

WABCO

APPENDIX XII

12-1

PUBLIC UTILITY COMMISSIONER OF OREGON

PUBLIC SERVICE BUILDING • SALEM 97310 • Telephone (503) 378-6675

January 29, 1973

TOM McCALL
GOVERNOR

DIARMUID F. O'SCANNLAIN
Commissioner

• • •

Regulatory Programs:

ENERGY
Electric Power Division
Natural Gas Division

TELECOMMUNICATIONS
Telephone and Telegraph Division

WATER-ENVIRONMENTAL AFFAIRS
Water Utilities Division

MOTOR CARRIERS
Motor Carrier Enforcement Division
Motor Carrier Rates Division
Motor Carrier Permits and Accounts Division

RAIL-AIR-MARINE
Railroad Division

SUPPORT ACTIVITIES:
Consumer Services Division
Economic Research and Analysis Division
Proceedings Division
Administrative Services Division

To: Oregon Railroads, Cities, Counties, Councils of Governments, and other interested Parties

In order to better carry out his statutory responsibilities regarding the construction, alteration, and protection of railroad grade crossings, the Public Utility Commissioner of Oregon has decided to hold an informational hearing. The purpose of the hearing is to develop current costs and procedures for grade crossing construction and protection.

The Commissioner hopes to use this proceeding as a vehicle in developing policies and procedures for decisions such as the necessary construction materials and protective devices for grade crossings and the costs associated with these items.

In order to provide for an orderly procedure, the Commissioner has required those railroads that are responsible for the majority of the crossings and crossing protection in the State of Oregon to furnish detailed cost estimates and justification for a series of sample situations. The Commissioner has also invited all other interested persons to participate in the hearing. Both the railroads and other interested parties will be required to pre-file any comments or questions they might have regarding construction costs and maintenance costs.

At the hearing it is our hope that the railroads will explain their required submissions and answer responsible questions regarding the data contained in those submissions. We hope that all interested parties including cities, counties, councils of governments, and railroads will take this opportunity to participate in what is essentially a fact-finding undertaking.

Attached to this letter is the order instituting the proceeding and the information request which the railroads will be required to submit. Submissions will be due on or before March 2, 1973, and the hearing will be held in Salem on March 7, 1973. Detailed

information on the submissions and the time and place of hearing are contained in the Commissioner's order.

We urge all those interested in crossing construction and maintenance to participate in this proceeding.

Very truly yours,

DIARMUID F. O'SCANNLAIN
Public Utility Commissioner

Lionel Topaz
Assistant Commissioner
Rail-Air-Marine

LT:sc
attachment

12-3

Order No. 73-88

BEFORE THE PUBLIC UTILITY COMMISSIONER

OF OREGON

FI 02

In the Matter of the Investigation of Railroad-Highway Grade Crossing Installation and Maintenance on the Commissioner's Own Motion Pursuant to ORS 756.070.	ORDER

The Public Utility Commissioner of Oregon is charged by statute to prescribe the manner of construction, maintenance, and use of railroad-highway grade crossings. The Commissioner is also required to apportion the costs of construction and maintenance of grade crossings including installation and maintenance of signals or other warning or protective devices.

The Commissioner has determined that a hearing be held to examine certain aspects of crossing construction and maintenance. In order to provide for an orderly presentation of information, it is

ORDERED that:

1. All Class I linehaul railroads which are responsible for the construction or maintenance of public railroad-highway grade crossings within this state shall comply with the information request, identified as Appendix A, attached to and made a part of this order.

2. All other railroads, public authorities and interested parties may submit statements and exhibits as may be pertinent to the items requested of the railroads in Appendix A.

3. All submissions shall be submitted to the Commissioner on or before March 2, 1973.

Order No. 73-88

Notice hereby is given that hearing in the above entitled matter will be held as follows:

DATE: Wednesday, March 7, 1973

TIME: 9:30 a.m.

PLACE: Room 101
Public Service Building
Salem, Oregon

Made, entered and effective JANUARY 31 1973.

DIARMUID F. O'SCANNLAIN
Public Utility Commissioner

12-5

PUBLIC UTILITY COMMISSIONER OF OREGON

PUBLIC SERVICE BUILDING • SALEM 97310 • Telephone (503) 378-6351

TOM McCALL
GOVERNOR

RICHARD W. SABIN
Commissioner

February 16, 1973

FI-02

To: All interested parties:

In the Matter of the Investigation of Railroad-Highway Grade Crossing Installation and Maintenance on the Commissioner's Own Motion Pursuant to ORS 756.070.

Under our original order in this matter those Class I line-haul railroads which serve Oregon and which maintain one or more grade crossings in this state were ordered to furnish certain information by March 2, 1973 relative to costs of installing and maintaining certain crossing components, signal and actuation devices. These railroads have asked for an extension of time in which to furnish the information requested.

As you can see, we have granted an extension of approximately 30 days for the furnishing of the written information requested and have reset the hearing date in this matter.

This action was taken to help ensure that the information generated in this investigatory proceeding will be as complete and useful to all concerned as possible.

The written information requested is due in this office on or before April 2, 1973. The hearing in this matter is set for April 10, 1973.

Yours very truly,

RICHARD W. SABIN
Public Utility Commissioner

David J. Astle

David J. Astle
Administrator
Railroad Division

DJA:sc
Encl: Order No. 73-113

ORS 756.040(1) The commissioner . . . "shall represent the customers of any public utility, railroad or motor carrier, and . . . he shall make use of the jurisdiction and power of his office to protect such customers, and the public generally, from unjust and unreasonable exactions and practices and to obtain for them adequate service at fair and reasonable rates."

Order # 73-113

BEFORE THE PUBLIC UTILITY COMMISSIONER

OF OREGON

FI 02

In the matter of the investigation of railroad-highway grade crossing installation and maintenance (on the Commissioner's own motion) pursuant to ORS 756.070.	))))	ORDER CHANGING HEARING DATE

On January 24, 1973, Commissioner's Order #72-88 issued setting the hearing in the above-entitled matter for Wednesday, March 7, 1973, and requiring submissions to be filed on March 2, 1973.

Postponement of the hearing and date for filing the submissions have been requested by the Class I railroads. After careful consideration, the Commissioner herein grants the requests; and

ORDERS that:

1. All statements and exhibits are to be submitted to the Commissioner for filing on or before April 2, 1973.

2. Hearing in the matter will be held as follows:

   DATE: ~~Wednesday~~ Tuesday April 10, 1973

   TIME: 9:30 a.m.

   PLACE: Room 101
   Public Service Building
   Salem, Oregon

Made, entered and effective FEBRUARY 14 1973.

PUBLIC UTILITY COMMISSIONER OF OREGON

Richard W. Sabin
Public Utility Commissioner

Appendix A

INFORMATION REQUEST

PART I

GENERAL INSTRUCTIONS AND ASSUMPTIONS

The specific items for which cost figures are requested in this proceeding are detailed in Parts II, III, IV and V below. All cost figures submitted for materials should be estimates based on the best cost information now available from manufacturers and suppliers. All cost figures submitted covering labor and overhead on the initial installation of items requested should be best estimates based on experience whenever possible, adjusted, if necessary, to reflect current price, wage levels and working conditions. Cost figures submitted for future maintenance should assume constant dollars (no adjustment for possible inflation).

Case Situations

The following "case situations" are to be used as the basic guidelines for computing costs for the items requested under Parts II, III, IV and V of this information request. Costs should be computed on each item requested only for those case situations specified for that particular item. The following general assumptions underlie each of the individual case situations:

i - The highway consists of two 12 foot traveled lanes and two 8 foot shoulders, all paved with asphaltic concrete. Highway alignment is tangent and on level grade in crossing area.

ii - The railroad is in tangent alignment on level grade. Train movements consist of the average experience of your railroad as to number of cars, locomotive units, and gross weight for the type of operation indicated. Existing rail in crossing area is of weight indicated in case situation and of average age for rail of that weight range.

iii - The highway and the railroad intersect at a right angle (90°). There are no other road intersections or railroad track switches in the crossing area other than those indicated under each case situation.

iv - There will be no significant change in highway or rail traffic volumes over a 20-year period.

Case Situation Descriptions

HIGHWAY CASES:

Case No.	Vehicles per Day	Heavy Truck Traffic
1	0 - 500	very little
2	1000 - 2000	normal for traffic volume
3	4000+	normal for traffic volume

RAILROAD CASES:

Case No.	No. of Tracks		Train Movements				Signal System	Rail Weight prior to item Installation**
	Main	Spur*	No. Thru	at speed of	No. Switch	at speed of		
A	1	0	2	15-20	0	-	None	Light
B	1	0	2	15-20	2-4	5-10	None	Light
C	1	0	4	40-50	0	-	None	Medium
D	1	0	4	40-50	2-4	5-10	None	Medium
E	1	0	6	50-60	0	-	ABS	Heavy
F	1	0	6	50-60	2-4	5-10	ABS	Heavy
G	1	0	6	25-60	0	-	ABS	Heavy
H	1	0	15	20	0	-	ABS	Heavy
J	2	0	20	50-60	0	-	ABS	Heavy
K	2	0	20	25-50	0	-	ABS	Heavy
L	1	1	2	15-20	2-4	5-10	None	Light
M	1	1	4	40-50	2-4	5-10	None	Medium
N	1	1	15	20-25	2-4	5-10	ABS	Heavy
P	1	1	15	50-60	2-4	5-10	ABS	Heavy

*Switch to spur track is approximately 400 feet from crossing. At crossing the main track and switch track are approximately 16 feet apart and parallel to each other.

**Assume the following regarding rail weights:

Light = 75-90 pound rail
Medium = 110-120 pound rail
Heavy = 130 pounds or more

PART II

12-9

INSTALLATION OF CROSSING SURFACES

Instructions

Using the basic assumptions and instructions set forth in Part I (except where otherwise indicated in Item II-1 below), please furnish for each item listed below a complete estimated cost breakdown for the following operations:

(1) Present installation of item --

  (a) without any replacement of existing rail; and
  (b) with replacement of existing rail with rail meeting current standards for traffic indicated.

(2) Future maintenance of item over a 20-year period (including total replacement cost, assuming constant dollars, if replacement of the installation would normally be deemed necessary one or more times over the 20-year period) --

  (a) assuming one rail relay through crossing in the 20-year period (but including only the additional cost of the relay directly chargeable to the existence of the crossing); and
  (b) assuming no rail relay through the crossing in the 20-year period.

The total cost for each item should be broken down into its various material (such as the number and type of ties, the weight and lineal feet of rail, number of tie plates, angle bars, bolts, length and type of planking, volume and type of ballast, gravel, asphalt, etc.) and labor components. For the sake of simplicity, assume that an entirely new crossing is being constructed in each instance (no prior highway at the site), and that the railroad is responsible for installing that portion of the crossing area lying between lines drawn two feet outside each rail. Make all reasonable additional assumptions necessary to furnish the information requested in this part, and specify all additional assumptions made, if any.

If there are factors other than the dollar cost of installation and maintenance that significantly influence your choice of a particular item in this category, please so state and explain in some detail.

Item II-1: Gravel Surface (assume for this item only a 30-foot gravel surfaced highway).

Compute costs for case situations: 1-A, C, E, J, L*

---

*"Compute for case situations: 1-A, C, E, J, L" means make cost computations for cases 1A, 1C, 1E, 1J, 1L. Case "1A" is case where highway volume is less than 500 vehicles and railroad consists of 1 main branch line track with an average of 2 through train movements at 15-20 mph and no switching movements. There is no train movement signal system.

Item II-2: Asphalt Surface

Compute costs for case situations: 1-A, C, E, H, J, L
2-A, C, E, H, J, L
3-A, C, E, H, J, L

Item II-3: Asphalt with Timber Headers

Compute costs for case situations: 1-A, C, E, H, J, L
2-A, C, E, H, J, L
3-A, C, E, H, J, L

Item II-4: Softwood Timber Planking

Compute costs for case situations: 1-A, C, E, H, J, L
2-A, C, E, H, J, L
3-A, C, E, H, J, L

Item II-5: Treated Hardwood

Compute costs for case situations: 1-A, C, E, H, J, L
2-A, C, E, H, J, L
3-A, C, E, H, J, L

Item II-6: Rubber Surface

Compute costs for case situations: 1-A, C, E, H, J, L
2-A, C, E, H, J, L
3-A, C, E, H, J, L

PART III

ACTUATION DEVICES

12-11

Instructions

Using the basic assumptions and instructions set forth in Part I, please furnish for each item listed below a complete estimated cost breakdown for the following operations:

(1) Present installation of item:

(a) Assuming devices will actuate two Standard No. 2 flashing light signals and gongs;
(b) Assuming devices will actuate two Standard No. 4 automatic gates in conjunction with two Standard No. 2 flashing lights and gongs.

(2) Future maintenance over a 20-year period:

(a) Assuming devices will actuate two Standard No. 2 flashing light signals and gongs;
(b) Assuming devices will actuate two Standard No. 4 automatic gates in conjunction with two Standard No. 2 flashing lights and gongs.

On future maintenance, if track relay during twenty-year period is included in costs include only that portion of relay cost over and above relay cost necessary if crossing not in existence. For estimating costs of future maintenance, use AAR maintenance units, if available, as basis. Specify clearly the number of maintenance units used and the average cost per unit. Make all reasonable additional assumptions necessary to furnish the cost information requested in this part, and specify all additional assumptions made, if any. If there are factors other than the dollar cost of installation and maintenance which significantly influence your choice of a particular item in this category, please so state and explain in some detail.

For each item listed below compute costs for case situations A through P. If the cost breakdown for any item in one case situation is substantially the same as the cost breakdown for that item in a previously listed case situation, please so indicate and do not repeat the entire breakdown, but list in detail only the major points of difference.

Item III-1: Standard Track Circuits*

Item III-1A: Addition of Time-Out Devices (on main tracks only) to Item III-1.

Item III-2: Motion Sensors*

Item III-3: Crossing Predictor Units*

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*For case situations L, M, N, P explain how actuation is accomplished for spur track movements (via separate island circuits or some other means).

PART IV

PROTECTIVE DEVICES

Instructions

Using the basic assumptions and instructions set forth in Part I, please furnish for each item listed below a complete estimated cost breakdown for the following operations:

(1) Present installation (exclusive of all equipment necessary to actuate the device).

(2) Future maintenance of the device (exclusive of actuation equipment) over a 20-year period.

Use AAR maintenance units, if available, as basis for estimating future maintenance costs. Specify the number of maintenance units used and the average cost per unit. Make all reasonable additional assumptions necessary to furnish the information requested in this part and specify all additional assumptions made, if any.

For each item listed below compute costs for case situations 2-A, J, L, P.

Item IV-1: Two Standard No. 1R Crossbucks

Item IV-2: Two Standard No. 2 Flashing Light Signals and Gongs

Item IV-3: Two Standard No. 2B Cantilevered Flashing Light Signals and Gongs

Item IV-4: Two Standard No. 4 Automatic Gate Signals plus two Standard No. 2 Flashing Light Signals and Gongs

Item IV-5: Two Standard No. 4 Automatic Gate Signals plus two Standard No. 2B Cantilevered Flashing Light Signals and Gongs

PART V

12-13

PROTECTIVE SYSTEMS

Instructions

Please furnish total cost figures for installation of the following complete protection packages for case situations: 2-A, J, L, P.

Item No.	System	
	Actuation Device +	Protective Device
V-1	Standard Track Circuits (Item III-1)	Standard No. 2 (Item IV-2)
V-2	Standard Track Circuits (Item III-1)	Standard No. 4 + Standard No. 2 (Item IV-4)
V-3	Standard Track Circuits plus Time-Out Devices (Item III-1 + III-1A)	Standard No. 2 (Item IV-2)
V-4	Standard Track Circuits plus Time-Out Devices (Item III-1 + III-1A)	Standard No. 4 + Standard No. 2 (Item IV-4)
V-5	Motion Sensors (Item III-2)	Standard No. 2 (Item IV-2)
V-6	Motion Sensors (Item III-2)	Standard No. 4 (Item IV-4)
V-7	Crossing Predictors (Item III-3)	Standard No. 2 (Item IV-2)
V-8	Crossing Predictors (Item III-3)	Standard No. 4 + Standard No. 2 (Item IV-4)

FI-02 Information Response Comparison Form

PART III - ACTUATION DEVICES 12-14

Comparison of Installation Costs for Item No. III-1
(Installation/Maintenance)

Description: Standard Track Circuits

Case Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	N/S	6305 2075 10110	6745 2500 9245
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	6455 2325 10510	6780 2540 9320
D	Materials Labor Total	"	"	"
E	Materials Labor Total	"	8520 2270 10790	8670 3270 11940
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	13410 5040 18950
H	Materials Labor Total	"	"	8670 3270 11940
J	Materials Labor Total	"	10630 2710 15070	21860 7410 29270
K	Materials Labor Total	"	"	24205 8210 32415
L	Materials Labor Total	"	8210 1195 12315	9140 2900 [illegible]

12-15

Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	N/S	6305 2075 10110	6745 2500 9245
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	6495 2325 10 510	6780 2540 9320
D	Materials Labor Total	"	"	"
E	Materials Labor Total	"	8520 2270 10 790	8670 3270 11940
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	13410 5040 18950
H	Materials Labor Total	"	"	8670 3270 11940
J	Materials Labor Total	"	12 860 2210 15070	21860 7410 29270
K	Materials Labor Total	"	"	29205 8210 32415
L	Materials Labor Total	"	8210 1175 12 315	9140 2900 12040
M	Materials Labor Total	"	8560 1425 12715	9180 3015 12 195
N	Materials Labor Total	"	5535 1475 12740	14725 4565 19290
P	Materials Labor Total	"	"	14815 4640 19455

SP Total includes a 1730 discount.

12-16

Case Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	N/S	6000	6000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	"	8000	8000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	12000
H	Materials Labor Total	"	"	8000
J	Materials Labor Total	"	16000	16000
K	Materials Labor Total	"	"	20000
L	Materials Labor Total	"	8000	8000
M	Materials Labor Total	"	"	8000
N	Materials Labor Total	"	10000	1000
P	Materials Labor Total	"	"	"

FI-02 Information Response Comparison Form

PART III - ACTUATION DEVICES

12-17

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. III- 1

Description: Standard Track Circuits

Case Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	N/S	6000	6000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	"	8000	8000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	12000
H	Materials Labor Total	"	"	8000
J	Materials Labor Total	"	16000	16000
K	Materials Labor Total	"	"	20000
L	Materials Labor Total	"	8000	8000

12-18

Case Letter	Type of Expense	BN *	SP (X)	UP	
A	Materials Labor Total	9365 2645 13210	10,370 3000 16015	4170 1290 5460	14[illegible]
B	Materials Labor Total	9395 2645 13245	"	"	1[illegible]
C	Materials Labor Total	9460 2645 13315	19210 5645 27500	7025 2550 9575	18[illegible]
D	Materials Labor Total	"	"	9270	18[illegible]
E	Materials Labor Total	12060 2645 16175	18,640 5945 29230	6350 2400 8750	20[illegible]
F	Materials Labor Total	"	"	"	1[illegible]
G	Materials Labor Total	20,395 4155 27005	"	"	17,[illegible]
H	Materials Labor Total	11515 2645 15575	8600 3250 16495	"	20[illegible]
J	Materials Labor Total	18220 4155 24610	20400 8290 37255	21800 7410 6350 2400	29270 8750 38020
K	Materials Labor Total	31935 5660 41355	[illegible] 8190 36875	24205 8210 6350 2400	32415 8750 41165
L	Materials Labor Total	12,830 4155 18685	10575 3300 18520	9140 2400 4170 1290	12040 5460 [illegible]
M	Materials Labor Total	12890 4155 18.750	14[illegible] [illegible]5 30[illegible]75	9180 3615 7025 2550	12195 9575 21770
N	Materials Labor Total	15750 4155 21895	21005 5630 29280	14725 4565 9990 3640	19290 13630 [illegible]
P	Materials Labor Total	15900 4155 22060	22275 6130 31,050	14815 4640 9990 [illegible]	19455 [illegible]

bil * Diff. between Mat., Lab. & Total = Contingencies.
[illegible] = 2645 [illegible]

FI-02 Information Response Comparison Form

12-19

PART III - ACTUATION DEVICES

Comparison of Installation Costs for Item No. III-1A
(Installation/Maintenance)

Description: Standard Track Circuits + Time out Devices

Case Letter	Type of Expense	BN*	SP (X)	UP	
A	Materials	9365	10,370	4170	
	Labor	2645	3000	1290	
	Total	13210	16015	5460	11,70[illegible]
B	Materials	9395			
	Labor	2645			
	Total	13245	"	"	1[illegible]
C	Materials	9460	19210	7025	
	Labor	2645	5645	2550	18[illegible]95
	Total	13315	27500	9575	
D	Materials				
	Labor	"			18[illegible]
	Total		"	9270	
E	Materials	12060	18,[illegible]	6350	
	Labor	2645	5945	2400	
	Total	16175	29230	8750	20,6[illegible]
F	Materials				
	Labor	"			1[illegible]
	Total		"	"	
G	Materials	20,395			
	Labor	4155	"		17,[illegible]00
	Total	27005		"	
H	Materials	11515	8600		
	Labor	2645	[illegible]		20,[illegible]
	Total	15525	16,4[illegible]	"	
J	Materials	18220	2[illegible]	21860 / 7410	[illegible]
	Labor	4155	8290	6350	[illegible]
	Total	[illegible]	27,[illegible]	2[illegible]	[illegible]
K	Materials	31435		29265 / 2210	32,[illegible]
	Labor	5660	[illegible]190	6350 / 2[illegible]	[illegible]
	Total	[illegible]	[illegible]6,575		41165
L	Materials	12,83[illegible]	15,575	7140 / [illegible]	12040
	Labor	4155	3300	4120	

FI-02 Information Response Comparison Form

PART III - ACTUATION DEVICES 12-20

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. III-1A

Description: Standard Track Circuits + Time Out Devices

Case Letter	Type of Expense	BN*	SP	UP
A	Materials Labor Total	10000	12000	7000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	20000	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	12000	22000	6000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	18000	22000	"
H	Materials Labor Total	12000	14000	"
J	Materials Labor Total	29000	26000	"
K	Materials Labor Total	36000	"	"
L	Materials Labor Total			7000

Case Letter	Type of Expense	BN*	SP	UP
A	Materials Labor Total	10000	12000	7000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	20000	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	12000	22000	6000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	18000	22000	"
H	Materials Labor Total	12000	14000	"
J	Materials Labor Total	24000	26000	"
K	Materials Labor Total	36000	"	"
L	Materials Labor Total	15000	14000	7000
M	Materials Labor Total	"	22000	"
N	Materials Labor Total	17000	24000	8000
P	Materials Labor Total	"	"	"

*Estimated @ 20% BN annual maintenance figure submitted

FI-02 Information Response Comparison Form

12-22

PART III - ACTUATION DEVICES

Comparison of Installation Costs for Item No. III- 2
(Installation/Maintenance)

Description: Motion Sensors

Case Letter	Type of Expense	BN*	SP ⊕	UP
A	Materials	11360	8640	8390
	Labor	2645	2500	2610
	Total	15405	12880	11000
B	Materials	"	"	"
	Labor			
	Total			
C	Materials	11675	9030	8435
	Labor	2645	2700	2680
	Total	15255	13470	11115
D	Materials	"		"
	Labor		"	
	Total			
E	Materials	10310	10485	10775
	Labor	2645	3400	4970
	Total	14250	14125	15745
F	Materials	"	"	"
	Labor			
	Total			
G	Materials	21520		"
	Labor	4155	"	
	Total	23245		
H	Materials	10310		
	Labor	2645	"	"
	Total	14250		
J	Materials	16170	14920	16760
	Labor	4155	6980	4950
	Total	22360	23640	21710
K	Materials	35330		"
	Labor	5660	"	
	Total	45990		
L	Materials	14090	10275	9720
	Labor	4155	2710	3190
	Total	20470	14725	12910

Case Letter	Type of Expense	BN *	SP (1)	UP 12-23
A	Materials	11360	8640	8390
	Labor	2645	2500	2610
	Total	15425	12880	11000
B	Materials			
	Labor	"	"	"
	Total			
C	Materials	11675	9030	8435
	Labor	2645	2700	2680
	Total	15255	13470	11115
D	Materials			"
	Labor	"		
	Total		"	
E	Materials	10310	10485	10775
	Labor	2645	3400	4970
	Total	14250	16125	15745
F	Materials			
	Labor	"		"
	Total		"	
G	Materials	21520		
	Labor	4155		"
	Total	23245	"	
H	Materials	10310		
	Labor	2645		
	Total	14250	"	"
J	Materials	16170	14920	16760
	Labor	4155	6980	4950
	Total	22360	23640	21710
K	Materials	35330		
	Labor	5660		"
	Total	45990	"	
L	Materials	14090	10275	9720
	Labor	4155	2710	3190
	Total	20070	14725	12910
M	Materials	14155	10475	9765
	Labor	4155	3105	3265
	Total	20140	15320	13030
N	Materials	12955	12785	12560
	Labor	4155	3655	4060
	Total	18820	18180	16620
P	Materials		13135	
	Labor	"	4005	"
	Total		18[illegible]0	

* Diff. between Mat. & Lab. = Contingencies
(1) [illegible] total includes 1790 [illegible]

FI-02 Information Response Comparison Form

12-24

PART III - ACTUATION DEVICES

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. III-2

Description: Motion Sensors

Case Letter	Type of Expense	BN *	SP	UP
A	Materials Labor Total	16000	8000	10,000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	14000	10000	12000
F	Materials Labor Total	10000	"	"
G	Materials Labor Total	21000	"	"
H	Materials Labor Total	14000	"	"
J	Materials Labor Total	28000	20000	24000
K	Materials Labor Total	48000	"	"
L	Materials Labor Total			

Case Letter	Type of Expense	BN *	SP	UP
A	Materials Labor Total	16000	8000	10,000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	14000	10000	12000
F	Materials Labor Total	14000	"	"
G	Materials Labor Total	21000	"	"
H	Materials Labor Total	14000	"	"
J	Materials Labor Total	28000	20000	24000
K	Materials Labor Total	48000	"	"
L	Materials Labor Total	19000	10000	12000
M	Materials Labor Total	"	"	"
N	Materials Labor Total	16000	12000	14000
P	Materials Labor Total	"	"	14000

* 50% of annual Maintenance figure

FI-02 Information Response Comparison Form

12-26

PART III - ACTUATION DEVICES

Comparison of Installation (Installation/Maintenance) Costs for Item No. III- 3

Description: Crossing Predictor Units

Case Letter	Type of Expense	BN*	SP	UP
A	Materials	15765	12345	17485
	Labor	2645	2200	2900
	Total	20,250	16780	20485
B	Materials	"	"	"
	Labor			
	Total			
C	Materials	15825	12525	17635
	Labor	2645	2620	2970
	Total	20320	17400	20605
D	Materials	"	"	"
	Labor			
	Total			
E	Materials	14755	14605	19870
	Labor	2645	3800	3990
	Total	19140	20660	23860
F	Materials	"	"	"
	Labor			
	Total			
G	Materials	"	"	"
	Labor			
	Total			
H	Materials		14015	
	Labor		2750	
	Total	"	19020	"
J	Materials	25050	19450	32920
	Labor	4155	4495	7430
	Total	32125	26200	40350
K	Materials	"	"	"
	Labor			
	Total			
L	Materials	17845	14330	19130
	Labor	4155	2445	3555
	Total	21700	19020	22685

Case Letter	Type of Expense	BN*	SP	UP
A	Materials	15765	12365	17485
	Labor	2645	2200	2900
	Total	20,250	16780	20485
B	Materials	"		"
	Labor		"	
	Total			
C	Materials	15825	12525	17635
	Labor	2645	2620	2970
	Total	20320	17400	20605
D	Materials	"	"	"
	Labor			
	Total			
E	Materials	14755	14605	19870
	Labor	2645	3800	3990
	Total	19140	20660	23860
F	Materials	"	"	"
	Labor			
	Total			
G	Materials	"	"	"
	Labor			
	Total			
H	Materials		14015	
	Labor	"	2750	"
	Total		19020	
J	Materials	25050	19450	32920
	Labor	4155	4495	7430
	Total	32125	26200	40350
K	Materials	"	"	"
	Labor			
	Total			
L	Materials	17845	14330	19130
	Labor	4155	2445	3555
	Total	24200	19030	22685
M	Materials	17905	14630	19150
	Labor	4155	2695	3625
	Total	24265	19580	22775
N	Materials	16320	16780	21870
	Labor	4155	4000	4355
	Total	22525	23025	26175
P	Materials		17160	
	Labor	"	4200	"
	Total		23615	

* Diff. between Mat. & Lab. = contingencies

Total includes 225 [illegible]

FI-02 Information Response Comparison Form

PART III - ACTUATION DEVICES 12-28

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. III-2

Description: Crossing Predictor Units

Case Letter	Type of Expense	BN*	SP	UP
A	Materials Labor Total	22000	20000	20000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	20000	22000	22000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	"
H	Materials Labor Total	"	"	"
J	Materials Labor Total	40000	24000	44000
K	Materials Labor Total	"	"	"
L	Materials Labor Total	24000	22000	22000

28

Letter	Type of Expense	BN *	SP	UP
A	Materials Labor Total	22000	20000	20000
B	Materials Labor Total	"	"	"
C	Materials Labor Total	"	"	"
D	Materials Labor Total	"	"	"
E	Materials Labor Total	20000	22000	22000
F	Materials Labor Total	"	"	"
G	Materials Labor Total	"	"	"
H	Materials Labor Total	"	"	"
J	Materials Labor Total	40000	24000	44000
K	Materials Labor Total	"	"	"
L	Materials Labor Total	24000	22000	22000
M	Materials Labor Total	"	"	"
N	Materials Labor Total	22000	24000	24000
P	Materials Labor Total	"	"	"

* 20x BN annual maintenance figures

FI-02 Information Response Comparison Form 12-30

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V- 1. Description: Standard Track Circuits + Std. #2.

Case No. 2 Letter	BN *	SP	UP
A	11415 3780 19715	15205	9265 4100 13365
J	20415 5290 28225	20165	24445 9160 33605
L	15025 5290 22345	17140	11600 4500 16100
P	18075 5290 25725	17835	17325 6240 23565

* BN - Total includes contingencies

FI-02 Information Response Comparison Form

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint.

Item No. V- 1 . Description: Std. Trk. Circuit.
+ Std. #2.

Case No. 2 Letter	BN	SP	UP
A	16 000	W/S	W/S
J	150 000	"	"
L	105,000	"	"
P	115,000	"	"

FI-02 Information Response Comparison Form

22-32

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Insti

Item No. V-2. Description: Std. Trk. Circuits + Std. #4 & Std #2

Case No. 2 Letter	BN *	SP	UP
A	16830 6045 25165	20510	16905 5480 21454
J	25,790 7550 36680	25770	23895 10545 34440
L	20455 7555 30750	23015	18560 5890 24450
P	23470 7555 34130	23440	23785 7630 31415

* BN Total includes contingencies

FI-02 Information Response Comparison Form

12-33

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint.

Item No. V- 2. Description: Std. Trk. Circuits
+ Std. #4 - Std. #2

Case No. 2 Letter	BN	SP	UP
A	24,000	N/S	N/S
J	38000	"	"
L	29000	"	"
P	31000	"	"

FI-02 Information Response Comparison Form 12-34

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V-3. Description: Std. Trk Circuits + Time-Out Div. + Std. #2

Case No. 2 Letter	BN*	SP	UP
A	11 415 3780 16 715	21110	13435 5390 19 825
J	20415 5290 28275	42450	30 790 11 560 42350
L	15025 5290 22345	23615	15830 5790 21620
P	18 095 5 290 25 725	36105	27325 9880 37205

* BN - Total, includes contingencies

FI-02 Information Response Comparison Form 12-35

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint

Item No. V-3. Description: Std. Trk. Circuits + T-O Div. + Std #2.

Case No. 2 Letter	BN	SP	UP
A	16000	N/S	N/S
J	30,000	"	"
L	21,000	"	"
P	23 000	"	"

FI-02 Information Response Comparison Form

12-36

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V- 4 . Description:- Std. Trk. Circuit + T-O Div.
+ Std. #4 + Std. #2

Case No. 2 Letter	BN*	SP	UP
A	16830 6045 25165	26715	20490 6780 27270
J	25790 7555 36620	48055	37635 12945 50580
L	20755 7555 30750	29220	23060 7180 30240
P	23470 7555 31130	41750	34340 11270 45610

* Total includes contingencies

FI-02 Information Response Comparison Form 12-37

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint

Item No. V- 4. Description: Std. Trk Circuits + T-O Div

+ Std #4 + Std. #2

Case No. 2 Letter	BN	SP	UP
A	24000	N/S	N/S
J	38000	"	"
L	29000	"	"
P	31000	"	"

FI-02 Information Response Comparison Form 12-38

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V-5. Description: Motion Sensors
+ Std. = 4

Case No. 2 Letter	* BN	SP	UP
A	13410 3780 18910	17975	10910 4210 15120
J	18365 5290 26020	28735	19840 6700 26540
L	16285 5290 23735	19820	12200 4790 17030
P	15150 5290 22425	23925	15080 5660 20740

* Total includes contingencies

FI-02 Information Response Comparison Form

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PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint.

Item No. V-5. Description: Motion Sensors + Std. #4

Case No. 2 Letter	BN	SP	UP
A	22 000	N/S	N/S
J	34000	"	
L	25000	"	
P	22 000	"	

FI-02 Information Response Comparison Form

12-40

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V- 6. Description: Motion Sensors + Standard #4 + Std #2

Case No. 2 Letter	BN*	SP	UP
A	18825 6045 27360	23875	17480 5600 23500
J	23740 7555 34425	31295	26010 8085 34095
L	21660 7555 32125	24125	19320 6180 25500
P	20525 7555 30890	28700	22150 7050 29700

* Total includes contingencies

FI-02 Information Response Comparison Form 12-41

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint.

Item No. V-6. Description: Motion Sensors + Std. #1 + Std #2

Case No. 2 Letter	BN	SP	UP
A	30000	N/S	N/S
J	42000	"	"
L	33000	"	
P	30000	"	

FI-02 Information Response Comparison Form

12-42

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V-7. Description: Crossing Predictors + Std. #2

Case No. 2 Letter	BN *	SP	UP
A	17815 3780 23255	21875	20105 4500 24605
J	27245 5290 35790	31295	35300 9180 44480
L	20090 5290 27545	24125	21650 5155 26805
P	18515 5290 26185	22710	24310 5955 30265

* Total includes contingencies

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FI-02 Information Response Comparison Form

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PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Unit.

Item No. V-7. Description: Predictors

+ Std = 2

Case No. 2 Letter	BN	SP	UP
A	28500	N/S	N/S
J	46000	"	"
L	30000	"	"
P	28000	"	"

FI-02 Information Response Comparison Form

12-44

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Inst.

Item No. V- 8. Description: Predictors

+ Std. #1 + Std #2

Case No. 2 Letter	BN *	SF	UP
A	23275 6045 32980	27480	26435 5890 32325
J	32620 7555 44195	36900	41985 10565 52705 ⊕
L	25415 7555 36270	29750	27980 6545 34525
P	23890 7555 34590	34315	30670 7345 38015

*Total includes contingencies

⊕ UP – figures do not add up - should be
26985 + 10565 = 37550

FI-02 Information Response Comparison Form

12-45

PART V - PROTECTIVE SYSTEMS

Comparison of Installation Costs for Maint.

Item No. V- 8. Description: Predictors

+ Std #1 + Std #2

Case No. 2 Letter	BN	SP	UP
A	36000	N/S	N/S
J	54000	"	"
L	38000	"	1
P	36000	"	1

FI-02 Information Response Comparison Form 12-46

PART IV - PROTECTIVE DEVICES

Comparison of Installation (Installation/Maintenance) Costs for Item No. IV-1

Description: 2 Std. #1R Crossbacks

Case No. 2				
Letter	Type of Expense	BN	SP	UP
A	Materials	61	120	
	Labor	52	40	
	Total	113	160	130
J	Materials	"	"	
	Labor			
	Total			140
L	Materials	"	"	
	Labor			
	Total			"
P	Materials	"	"	
	Labor			
	Total			"

FI-02 Information Response Comparison Form

12-47

PART IV - PROTECTIVE DEVICES

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. IV-1

Description: 2 St. #1R Crossbucks

Case No. 2 Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	N/S	160	100
J	Materials Labor Total	"	"	"
L	Materials Labor Total	"	"	"
P	Materials Labor Total	"	"	"

FI-02 Information Response Comparison Form

12-48

PART IV - PROTECTIVE DEVICES

Comparison of Installation (Installation/Maintenance) Costs for Item No. IV- 2

Description: Two Std. #2 El. Light Signals & bongo.

Case No. 2 Letter	Type of Expense	BN *	SP	UP
A	Materials	2050		2520
	Labor	1135		1600
	Total	3505	5095	4120
J	Materials	2195		2520
	Labor	1135		1750
	Total	3665	"	4330
L	Materials	"		2520
	Labor			1600
	Total		"	4120
P	Materials			
	Labor	"	"	"
	Total			

* BN - Diff. between Mat. + Lab & Total = contingencies

/

FI-02 Information Response Comparison Form

12-49

PART IV - PROTECTIVE DEVICES

Comparison of Maintenance (Installation/Maintenance) Costs for Item No. IV- 2

Description: Two Std. #2 Fl. Light Signals & Gates

Case No. 2 Letter	Type of Expense	BN*	SP	UP
A	Materials Labor Total	6000	6000	6000
J	Materials Labor Total	"	"	"
L	Materials Labor Total	"	"	"
P	Materials Labor Total	"	"	"

* BN 20 x Annual maint. cost.

FI-02 Information Response Comparison Form

12-50

PART IV - PROTECTIVE DEVICES

Comparison of Instal. (Installation/Maintenance) Costs for Item No. IV- 3

Description: 2 Std. #2R Cant. FL. Lt. Signals & Gongs

Case No. 2 Letter	Type of Expense	BN *	SP	UP
A	Materials	5460		7160
	Labor	2645		2580
	Total	8915	9195	9740
J	Materials	5600		7230
	Labor	2645		2580
	Total	9070	"	9810
L	Materials			7160
	Labor			2580
	Total	"	"	9740
P	Materials			
	Labor			
	Total	"	"	"

* BN - Diff between Mat. & Lab & Total = contingencies

FI-02 Information Response Comparison Form

12-51

PART IV - PROTECTIVE DEVICES

Comparison of Maint (Installation/Maintenance) Costs for Item No. IV- 3

Description: 2 Std. #2B Cent. Fl. Lt. Signals & Gongs

Case No. 2 Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	10000	12000	15 000
J	Materials Labor Total	"	"	"
L	Materials Labor Total	"	"	"
P	Materials Labor Total	"	"	"

FI-02 Information Response Comparison Form

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PART IV - PROTECTIVE-DEVICES

Comparison of Ist. (Installation/Maintenance) Costs for Item No. IV- 4

Description: 2 Gates + 2 FL. Lts.

Case No. 2 Letter	Type of Expense	BN*	SP	UP
A	Materials	7465		8860
	Labor	3400		2990
	Total	11950	10700	11840
J	Materials	7570		9220
	Labor	3400		3135
	Total	10970	"	12355
L	Materials	"		8840
	Labor			2990
	Total		"	11840
P	Materials	"		"
	Labor			
	Total		"	

* BN - Diff. between Mat. - Lab. & Total = contingencies

This sheet used for est.

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FI-02 Information Response Comparison Form

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PART IV - PROTECTIVE DEVICES

Comparison of Maint (Installation/Maintenance) Costs for Item No. IV- 4

Description: 2 Gates & 2 FL. LTs.

Case No. 2 Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	14000	14000	1401.0
J	Materials Labor Total	"	"	"
L	Materials Labor Total	"	"	"
P	Materials Labor Total	"	"	"

FI-02 Information Response Comparison Form 12-54

PART IV - PROTECTIVE DEVICES

Comparison of Est. (Installation/Maintenance) Costs for Item No. IV-5

Description: 2 Gates, 2 Cath FL. LT. & Conds

Case No. 2 Letter	Type of Expense	BN *	SP	UP
A	Materials	9225		13500
	Labor	4155		3720
	Total	14720	14290	17220
J	Materials	9430		13630
	Labor	4155		4010
	Total	14945	"	17640
L	Materials			13500
	Labor	"		3720
	Total		"	17220
P	Materials			
	Labor	"		"
	Total			

* Total includes contingencies

FI-02 Information Response Comparison Form 12-55

PART IV - PROTECTIVE DEVICES

Comparison of Maint. (Installation/Maintenance) Costs for Item No. IV-5

Description: 2 Gates, 2 Caut. FL. LT. & Gongs

Case No. 2 Letter	Type of Expense	BN	SP	UP
A	Materials Labor Total	18000	18000	18000
J	Materials Labor Total	"	"	"
L	Materials Labor Total	"	"	"
P	Materials Labor Total	"	"	"